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CARNIVOROUS PLANT NEWSLETTER

VOLUME 19, Numbers 3 & 4

SEPTEMBER & DECEMBER 1990





CARNIVOROUS PLANT NEWSLETTER

Official Journal of the
International Carnivorous
Plant Society



**Volume 19, Numbers 3 & 4
September & December 1990**

Front cover: *Drosera falconeri* in habitat - Darwin region.

Rear cover: *D. falconeri* X *D. dilata - petiolaris*. A natural hybrid from the Darwin region. Both photos by and copyrighted by Allen Lowrie. Please see article beginning on page 65.

The co-editors of CPN would like everyone to pay particular attention to the following policies regarding your dues to the ICPS.

All Correspondence regarding dues, address changes and missing issues should be sent to ICPS c/o Fullerton Arboretum, CSUF, Fullerton, CA 92634. DO NOT SEND TO THE CO-EDITORS. Checks for subscription and reprints should be made payable to ICPS.

All material for publication, comments and general correspondence about your plants, field trips or special noteworthy events relating to CP should be directed to one of the co-editors. We are interested in all news related to carnivorous plants and rely on the membership to supply us with this information so that we can share it with others.

Views expressed in this publication are those of the authors, not necessarily the editorial staff

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Editor's Corner

by
Leo C. Song, Jr.
Acting Business Manager

I wish to apologize again for the delays experienced in getting CPN into your hands. My thanks again for your patience and understanding. I also wish to acknowledge again those who came forward in a continuing commitment to help with the production of CPN. Marilyn Medlin, Public Affairs Office, California State University, Fullerton, is doing the graphics; Arthur and Erin North of Westminster, California, mailing list and labels; and Richard George of Riverside, California, who is handling inquiries for information and membership. Without them and you, CPN would not be possible.

In this double issue, you will find a renewal envelope. This is the only notice you will receive. If you do not need to renew at this time, please pass the envelope on to a friend or use it in any communication you may have with the Society.

For the past ten years, our rates have not changed, but due to the recent 25% across the board postal rate increase (which was determined, voted on and implemented by the Postal Commission all within 3 months!) as well as increases in printing costs, it is necessary to increase dues to the following rates. For the USA and Canada \$15.00/year; all others \$20.00/year. The back issue discount package will be, for five or more back volumes, USA and Canada \$12.50, all others \$17.50 per volume-year. Single year back issues will be at the new individual rate. Orders already received at the old rates will be honored.

Seed Bank

For more updated information on the Seed Bank inventory, please contact Gordon L. Snelling, 321 1/2 W. Palm Avenue, Monrovia CA 91016, U.S.A. Please include SASE or return postage. Overseas include 2 international reply coupons (IRC's).

News and Views

Steve Clemesha (Lot 6 Skinner Close, Avocado Heights, Woolgollia, NSW Australia 2456) writes:

Nepenthes is rather difficult to hybridize especially when one wants to choose the parents carefully rather than randomly cross them. Because the plants produce flowers of one sex on different plants, it is difficult to have them flower within a short time span for effective pollination to occur.

I have tried storing *Nepenthes* pollen in aluminum foil to send out to other breeders. The shiny side was best to use as it did not seem to stick too much as the dull side did. Pollen does stick to glass but because the material is hard and rigid, you can scrape it off with a label or blade. Glass slides can be labeled and stored in glass jars for several months with the pollen remaining quite viable but never as good as fresh material.

Freddy De Coninck (Rijkeklarenstraat 20, 9219, Gent, Belgium) writes:

This year in Belgium, we started a CP society. This is a non-profit society named

"Drosera" and the publications are in the Dutch language. I am the president and also an adherent of ICPS. We wish to have an open and friendly relationship with ICPS. We will publish 2 issues per year and the subscription price is 250 B francs.

Don Grove (505 Schuyler Rd., Silver Spring, MD 20910 USA, Tel. 301 565-3740, FAX 301 589-7223) writes:

I would like to establish contact with other carnivorous plant enthusiasts in the United States. Could you give me the names of any national organizations or individuals with whom I might compare notes and exchange plants? I would specifically like to obtain specimens of *Utricularia olivacea* from the Pine Barrens of New Jersey and *Utricularia purpurea* from New Hampshire.

I am also wondering if any *Cephalotus follicularis* is grown in the United States. My interest in Carnivorous Plants originated in Australia and I miss these Albany Pitcher Plants.

Randy Lamb (304 E. Pender St., Burnaby, BC V5C2M6, CANADA)

In my last article on the Fort Nelson, BC *S. purpurea* plant reserve (CPN 18:1, p 7-8, 1989), I described the area and its plants. Now I would like to report that the *S. purpurea* Ecological Reserve has added to its north side an "environmentally sensitive" zone. This addition doubles the area that the Ministry of Environment designated to prevent any further development to the area other than a float plane base by Parker lake. This site is significant for *S. purpurea* since it is further westward than San Francisco or Los Angeles and is less than 500 mi from the Pacific Ocean.

Joe Mazrimas (329 Helen Way, Livermore, CA 94550) writes:

The San Francisco County Garden Show which was held on August 24-26, 1990 hosted a great show of CP from members in the area. Participating in this year's show were: Charles and Barbara Powell, Larry and Sherry Logoteta, Kirk Henderson, Loretta, Glen and Gregory Lum, Geoffrey Wong, and Joe and Kathy Mazrimas. The best Australia CP prize went to Barbara Powell for a huge specimen of *Drosera petiolaris*. Best plant in the show was a spectacular *Drosera regia* grown by Geoffrey Wong. The exhibition of plants this year featured them by groups of genera spot-lighted throughout the room.

Want Ad

Rob Maharajh (168 Dalewood Avenue South, Hamilton, Ontario, Canada, L8S 1A4, Phone: 416-526-9600, Bitnet Address: Maharaj@McMaster.CA).

WANTED TO BUY: Fresh seed, plants, cuttings of *D. cistiflora* varieties, *D. pauciflora* variegates, *D. alba*, *D. polosia*, *D. affinis*, *D. madagascariensis*, *D. glabripes*, *D. ramantacea*, *D. stenopetala*, *D. arcturi*, *D. whittakeri*, *D. tubaestylus*, *N. carunculata*, *N. macfarlanea*, *N. rajah*, *Darlingtonia*, *S. flava* 'Copper Top', *Byblis gigantea*, *P. longifolia* any variety, *P. gypsicola*, *P. vallisneriifolia*, *P. pumila*, any Cuban and/or Mexican Pings. and/or hybrids beside *P. moranensis caudata*."

TS: *D. linearis* hibernicula and seed, *D. spathulata* varieties, *D. hamiltonii*, *D. multifida* 'Extrema', *D. Xwatari*, *D. cuneifolia*, *D. filiformis* *filiformis* and *D. filiformis* 'California Sunset' hibernicula (semi-mature), *D. adelae*, *D. dielsiana*, *D. burkeana*, *P. vulgaris* and *P. grandiflora* ssp. *pallida* hibernicula, *P. moranensis caudata* (semi-mature), *Cephalotus*, *U. longifolia*, and many others.

Previously Unnamed Australian *Drosera* and Their Published Names.

The following list is compiled from Allen Lowrie's book, Vol 2 and a formal description will be written by Dr. Neville Marchant at a future date. This list was sent in by Gordon Snelling.

- D. barbigera Planchon = syn D. drummondi
D. callistos = D. sp. 'The Lakes' (State Forest, Brookton Hwy.)
D. closterostigma = D. sp. 'Cataby'.
D. coolamon = D. sp. 'Kalbarri'
D. echinoblata = D. sp. 'camallo'
D. eneabba = D. sp. 'eneabba'
D. enodes = D.sp. 'Omissa-Marchant'
D. ericksonae = D.sp. 'Erickson's-omissa'
D. helodes = D. sp. 'bullsbrook'
D. hyperostigma = D. sp. 'platy-O'brien'
D. leioblata = D. sp. 'Steve's-palacea'
D. manniana = D. sp. 'Bannister'
D. nitidula ssp omissa x D. occidentalis ssp occidentalis= D. sp " Lake Badgerup"
D. occidentalis ssp. australis = D. sp. 'South coast'
D. omissa = D. nitidula ssp omissa
D. oreopodion = D. sp. 'Armadales'
D. rechingeri = D. sp. 'Regan's Ford'
D. roseana = D. sp. 'Steve's-dichro'
D. spilos = D. sp. 'muchea'
D. walyunga = D. sp. 'Walyunga' (National Park)

Corrected 6-12-90

The *Drosera petiolaris* Complex

By Allen Lowrie, 6 Glenn Place, Duncraig, 6023,
Western Australia

Following a close look at the *Drosera petiolaris* complex in the northern regions of Australia, the author has discovered a number of new taxa in this complex that warrant specific botanical classification.

Katsuhiko Kondo of Japan recognized three new species in the *D. petiolaris* complex and formally described them in Bot. Soc. Ser. 2, 57: 51-60 (1984). The three new *Drosera* species were *D. falconeri*, *D. lanata* and *D. dilatato-petiolaris*. The author agrees with K. Kondo's findings that these three new *Drosera* species are indeed species although they are clearly related to *D. petiolaris*.

Taxonomically, these three species are placed in *Droseraceae*-Section *Lasiocephala* along with *D. petiolaris* and *D. neo-caledonica* from New Caledonia. To this list, the author feels recognition of four more taxa, clearly related to the *D. petiolaris* 'complex, warrant species classification.

The four new *Drosera* only have field names at this stage and are described and illustrated in the following pages. To give the reader a better understanding of all the Australian *D. petiolaris* complex plants, descriptions and general observations of each taxa is as follows:

D. petiolaris R. Br ex DC., Prodr. 1: 318 (1824).

The type was collected on the Cook voyage by J. Banks on the Endeavor River, Queensland. This species is also found in the Darwin region and no doubt at suitable locations in between. *D. petiolaris* has also been recorded from New Guinea. This species generally grows in very shallow water and is easily recognized by its erect and semi-erect, long, narrow petioles and lamina having extremely long retentive glands.

D. falconeri Kondo and Tsang.

This species was first discovered by a Mr. Falconer (Darwin region) about ten years ago while collecting tropical fish for the late Peter Tsang of Queensland. Specimens were sent to Peter who in turn passed specimens onto Bill Lavarack of Queensland, a botanist with the Queensland National Parks. Specimens were also passed onto the author at this time. Only one location for *D. falconeri* was known...Finniss River, exactly where went to the grave with Peter Tsang. The Finniss River is nearly 100 Km long and branches in a number of directions in the upper reaches. Recent field studies however have turned up a number of locations for *D. falconeri*. It now can be stated that this species is common in the northern region of the Northern Territory. *D. falconeri* is unique in having the largest lamina within the *D. petiolaris* complex. Old, very mature plants produce reniform-shaped lamina 3cm across. In the field, the entire plant is reddish-maroon in color. The leaves within the rosette are always pressed flat to the soil surface.

D. dilatato-petiolaris Kondo.

This species is common in the Darwin region and is the plant that was described and illustrated by L. Diels (1906) in Das Pflanzenreich. This hardy species grows on slightly higher ground than *D. petiolaris*. The width of the petiole is variable but generally remains in the 3-5mm width from one habitat to the next. This species commonly produces plantlets from the base of the parent and forms large clumps over a number of years.

D. lanata Kondo

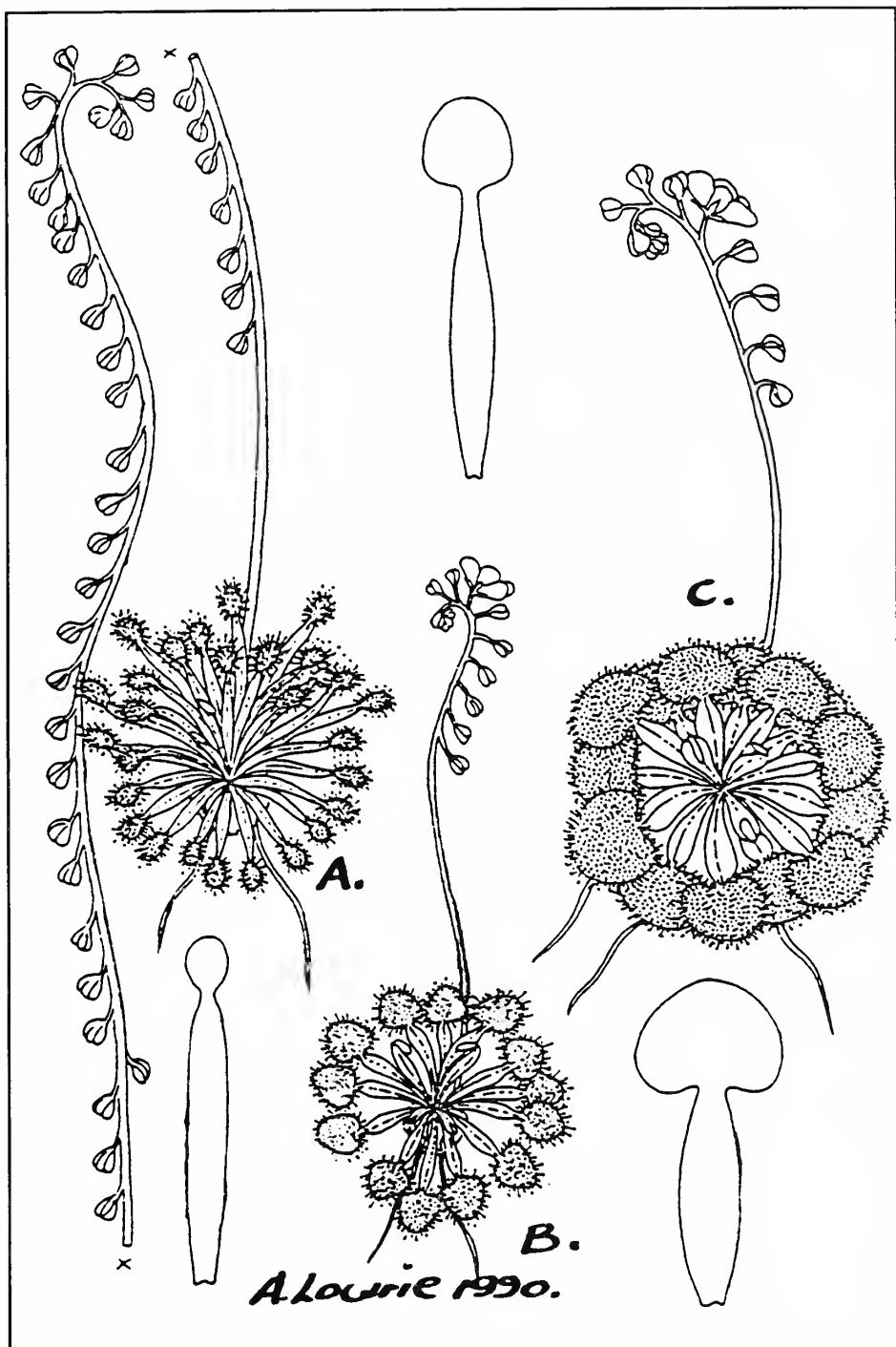
The author has not seen this species in the field yet but hopes to in April 1990 on the next expedition to Northern Australia. From Kondo's paper and material housed in the Northern Territory and Western Australian Herbariums, *D. lanata* is easy to recognize. This species has narrow petioles which are covered with numerous dendritic hairs (see illustration). This species forms a very leafy compact rosette and with the addition of the silvery, densely-placed, wooly, dendritic hairs-especially dense at the centre of the rosette, make this species unmistakable.

To the above recognized species, the author feels the following taxa warrant specific botanical recognition as species in their own right.

(NOTE! aff.=affinis= allied to.)

D. petiolaris aff. 'erect'

This taxa has been collected a number of times from different locations in the Northern Territory. This species grows in association with sandstone outcrops, generally where the water run-off is the greatest. This species can grow up to 35cm in height. Shorter specimens are self-supporting in their erect stance, however larger specimens generally lean on nearby herbs for support. The author has not seen specimens in the field as yet but has studied a number of pressed specimens in the Northern Territory and Western Australian Herbariums, as well as one live specimen kept for a short time at the Western Australian Herbarium. This species is unique and is easily recognized by its erect growth and extremely narrow petioles.



A. *D. Dilatato-petiolaris*
 B. *D. falconeri* x *D. dilatato-petiolaris*
 C. *D. falconeri*

D. petiolaris aff. "medium rosette"

This taxa produces a very compact basal rosette of leaves. The diameter of the rosette is at best only 5cm across. The inflorescence and scape, however, is up to 60cm in height. Three scapes per basal leafy rosette is common and appears quite out of proportion to the rosette. The petals are generally pink. The style/stigmas on most specimens are all white. However, pink stigmas are found on a few specimens. Although, all species within the *D. petiolaris* complex have varying degrees of hairiness on the scape and inflorescence, *D. petiolaris* aff. "Medium rosette" is the woolliest. This species is notable for having extremely long, woolly hairs on the scape and within the inflorescence arrangement. The fruits are large and woolly. This species also has strange hook-like projections above the anthers which at this stage appear to be unique only to this plant within the *D. petiolaris* complex.

D. petiolaris aff. 'Mini rosette'

The leafy basal rosette of this species is similar in arrangement to *D. petiolaris* aff. 'Medium rosette'. However, the lamina of the 'Mini rosette' is orbicular where the lamina of the 'Medium rosette' is elliptic-shaped. The leafy basal rosette of the 'Mini rosette' is at best 3cm in diameter, and generally smaller. In cultivation, this species can be likened to a pygmy *Drosera* (without the stipule bud). The inflorescence arrangement is short (up to 12cm in height) and like the 'Medium rosette' is extremely woolly. The petals are generally white with the overall flower diameter only 8mm across.

D. petiolaris aff. 'Kununurra'

This remarkable species has the same hairs and hairiness as *D. lunata*. However, this species in all other respects is quite different to *D. lunata*.

The author has observed specimens in the field up to 16cm in diameter, 6-10cm diameter, however, is the average flowering size. This species grows in sandy soils often near the bases of sandstone outcrops. Mature plants commonly form clumps of plants up to 30cm in diameter. Studies to date show the inflorescence arrangement on this species to be unique within the *D. petiolaris* complex. The arrangement is a one-sided raceme with the pedicels (nearly in pairs) alternating along the scape. The petals range in colour from white to pink with various shades inbetween. The flowers are large. The width and shape of the petioles is unusual and this combined with a few other facts show this taxa to be quite different to other plants within the *D. petiolaris* complex.

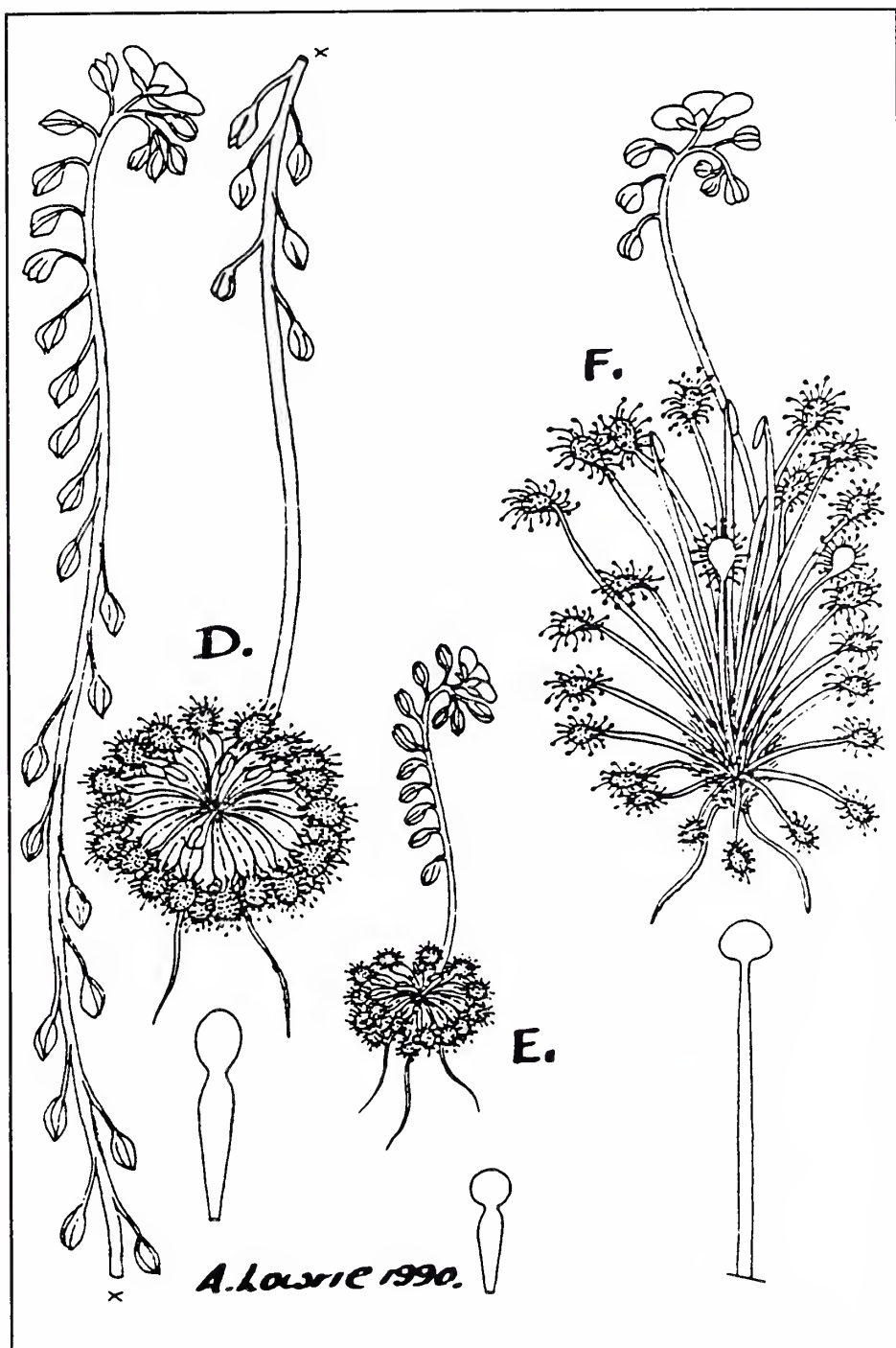
Hybrids between species have been found at a number of locations between a few of the above species. In cultivation, these hybrids are quite variable in overall appearance. However, all exhibit the basic format of a plant roughly equal between the two parents. The parents of these hybrids have been established in the field where hybrids were found. All hybrids produce robust growth in cultivation.

D. falconeri x *D. dilatato-petiolaris*

Some specimens are 4 to 5cm in diameter and others 10cm in diameter. The lamina on some hybrids is small and on others large. Some remain as single plants like *D. falconeri*. Others produce plantlets from the base of the parent plant like *D. dilatato-petiolaris*. Overall, there is about four recognizable forms amongst these hybrids and all are worthy of cultivation.

D. petiolaris x *D. dilatato-petiolaris*

This hybrid is intermediate between the two species. The hybrid is a short, compact



D. *D. petiolaris* aff. 'Medium rosette'

E. *D. petiolaris* aff. 'Mini rosette'

F. *D. petiolaris*

plant up to 4cm in diameter, with erect and semi-erect leaves. Its similar to *D. petiolaris* but more organized in even arrangement. Plantlets are produced from the base of the parent plant which can be detached and potted separately. The petioles are glabrous and green. The lamina generally is red.

As more field trips are undertaken, more hybrids no doubt will be discovered. Seed has been collected from the natural hybrid *D. falconeri* x *D. dilatato-petiolaris* and the seed appears full and normal. These have been sown and hopefully, they will be viable and germinate. If this is the case, it maybe possible to produce selected hybrids in cultivation.

Cultivation

All of the species described in this paper are easy to grow. Being tropical plants, they enjoy the warmth from Grolux light setups. The author is growing all species except *D. lanata* and *D. petiolaris* aff. 'Erect' under the same conditions in two housing arrangements. 1), An aquarium under a patio using two Grolux lights and one cool-white fluorescent lamp for illumination. 2) A fiberglass fully closed enclosure on a bench, under 50% shade-cloth in full sun.

The pots are regular plastic pots. The soil medium is straight German peat moss-put through a 8mm sieve to remove the coarse material. The pots are watered by the tray method to a depth of 1cm. In cultivation, these tropical plants continue to grow all year. In the wild, they go dormant in the dry season. Because of this dry season adaptation, each species is equipped with a 'bulb-like' reserve at the base of the leaves. In the wild, a plant can lose all its leaves in the dry season and remain dormant. When the rainy season (the wet) arrives, new growth is produced from the 'bulb-like' stock. This 'bulb-like' arrangement makes these plants very hardy and extremely hard to kill in cultivation.

All of these species produce beautiful leaf colouring in good natural light. Unfortunately, under artificial lighting, most of these colours are lost. The plants, although growing well, lean more towards various shades of green. Better colours however, can be achieved by placing the plants closer to the lights.

Propagation

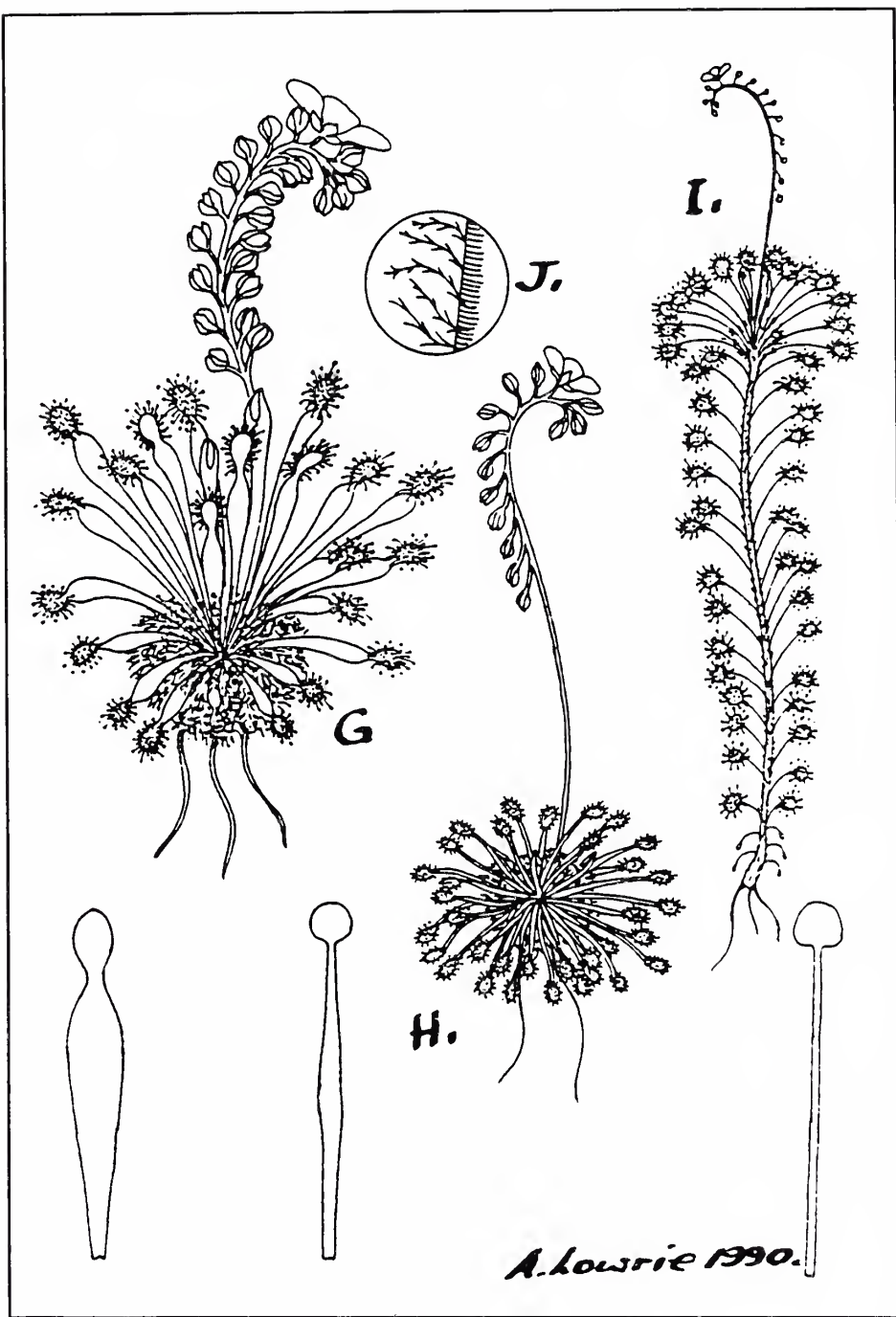
Seed works well but vegetative propagation at this stage is purely experimental in cultivation. Field observations have identified that all species are capable of vegetative propagation. Specimens of three species, *D. falconeri*, *D. petiolaris* and *D. dilatato-petiolaris* have been found with plantlets growing from the scape in tight-knit groups. These plantlets can be detached and grown as individuals.

In Kondo's book 'C.P. of the World in Colour', page 58, the right hand photo is that of *D. petiolaris*. If the reader looks carefully at this photo, the inflorescence on the right has a clump of small plantlets growing on the scape. (The centre photograph is *D. dilatato-petiolaris* and the left photograph is maybe *D. lanata*).

Observations have shown that some plants growing in the author's aquarium setup are producing outgrowths on some of the leaves. These outgrowths may turn into plantlets in time. These are being watched carefully to study their development cycle.

The author can see an exciting future for these plants in CP collections around the world. Hopefully, various methods will evolve through experimentation with propagation.

The possibilities of more species being discovered in the *D. petiolaris* complex is good. The author has seen a number of pressed specimens from expeditions to the wild and remote Mitchell Plateau region of North West-Western Australia. Some of the



G. *D. petiolaris* aff. 'Kununurra'

H. *D. lanata*

I. *D. petiolaris* aff. 'Erect'

J. Dendrite hairs

specimens appear to be new species of *Drosera* that warrant further collections and study for possible species classification.

CP Fountain Jar

By Ken D. Jones (P.O. Box 24218, San Jose, CA 95124)

As anyone who has ever tried to raise carnivorous plants knows, they generally don't have any tolerance for being allowed to dry out.

The general methods for preventing this are to grow in a sealed terrarium, water each plant everyday, or stand the pots in a shallow tray of water.

I have tried each of these methods with limited success. When I tried to grow in a sealed terrarium, the live spagnum grew faster than and soon overwhelmed the smaller plants.

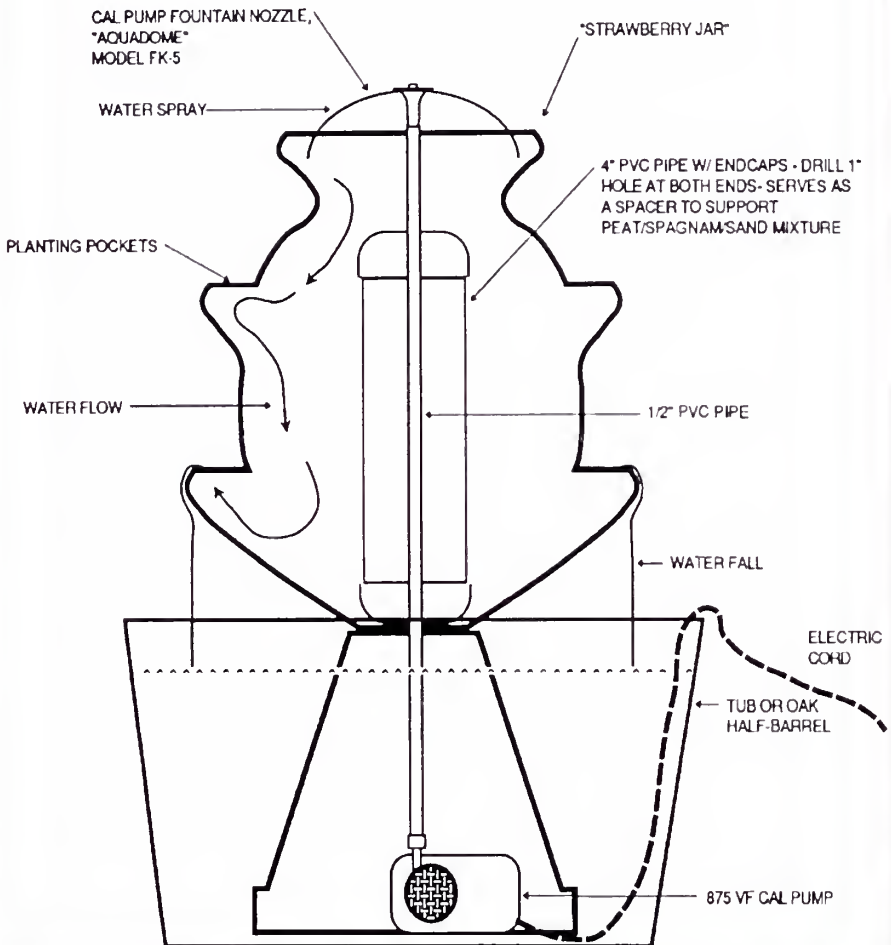
When I switched to a peat and sand mix, it too sprouted and rapidly buried smaller seedlings, I next tried individual watering. It only took one vacation with a 'forgetful' friend to watch over things to convince me that this wasn't the perfect solution either. So, I switched back to terrariums, but put the plants in individual pots sitting in 1/4 inch of water. This had the advantage of providing constant water and high enough humidity so the plants grew better than the moss. Unfortunately, another vacation proved that this was not the perfect solution either. (Crispy sundews don't recover too well)

As this point I was reminded of a device we used to use to provide water for our chickens. It consisted of a tray with a bottle of water inverted in it. A small channel under the lip of the bottle would allow water out of the bottle and air in until the water got up to the point that no more air could enter and the flow stopped. Unfortunately, while this system could maintain the needed 1/4 inch of water, it took up way too much space in the terrarium.

As a result, I went over to my local hardware store and spent a day or so trying to fit together various bits of plumbing to accomplish the same thing using a lot less space. After many false starts (and attempts to change the laws of physics) I finally ended up with the design shown in the photos. It consists of a two-liter bottle, a 3/4 inch slip to 1/2 inch threaded adapter and a 1/2 inch slip cross fitting. In the center of the cross fitting I drilled/carved/filed a half inch hole. Next, the inside of the 3/4 slip fitting must be roughed up and the neck of the bottle filed down to fit into it. The two are then glued together with a silicone aquarium sealant and allowed to cure.

After the sealant has cured, the bottle is filled with water and inverted into the hole drilled in the cross fitting. Depending on the fitting used, the threaded portion may have to be filed shorter to get the water to flow and then to adjust for the desired water level. In a ten gallon aquarium a two-liter bottle will last me about two weeks and takes up less space than a four-inch pot.

CP FOUNTAIN JAR



WATERGARDENS

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Waterfalls, Fountains, Koi & Lily Ponds

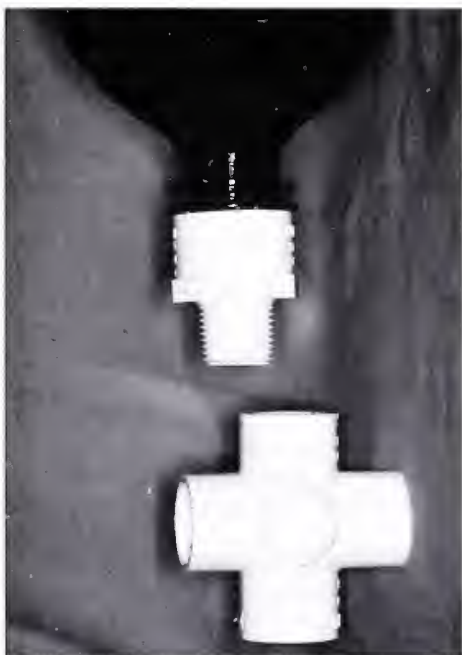
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CP FOUNTAIN JAR

SIDE	Drawn BY	Ken D. Jones	EDUCATION: AG	101
	ph	408/281-0540		
	SCALE	NONE	DATE	5/19/90

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05/19/90/02/01



Detail of Cap Assembly



Assembled Cap

Photos by Bill Weaver



CP Fountain Jar in Terrarium

Nepenthes and Rockwool

By Freddy De Coninck (Rijckelarenstraat 20, 9219, Gent, BELGIUM)

Here in the botanical garden of the University of Gent, we are cultivating *Nepenthes* in rockwool. Because sphagnum moss is scarce and protected by law in Belgium and because a mix of orchid bark, perlite and peat gives no satisfaction, we decided to try rockwool with *Nepenthes* since good results are seen with orchids. We see that *Nepenthes* grow faster, have bigger pitchers and there is no stagnation of growth after repotting because the roots were not disturbed.

There are two sorts of horticultural rockwool, the wet and the dry type. The wet type can absorb 80% water and the dry type about 5% water. We use about a 50-50% mix. Its essential to use plastic pots with drainage holes because clay pots dry out too quickly. The rockwool becomes almost dry after evaporation, and once the mix has dried up completely, it is not possible to wet the mix again due to structural changes of the mix. So what do you do if you want to repot in rockwool? First, take your *Nepenthes* out of the compost and clean the roots underwater until no old compost is retained. You take a plastic pot and put some dry rockwool in the pot. Then you take the *Nepenthes* and set the roots in the pot and add the 50-50 rockwool mix. After filling the entire pot with mix, we push slightly until the plant does not move. The mix is watered with plenty of water.

Because there are no nutrients in rockwool, we use a fertilizer (20-20-20) and spray *Nepenthes* about every two weeks with it in the growing season and about once a month during winter. In winter, we prune back and take cuttings also using rockwool as mix. The cuttings are inserted about half the depth in this mix and we may spray them everyday to keep the humidity high. More than 90% of the cuttings strike and we leave them undisturbed until good growth is visible. Then we take the rooted cuttings out and pot them up. When repotting plants which are already in rockwool, you have the advantage that there is no stagnation in growth. At the bottom of the new pot some dry rockwool is added and then this is followed by the plant together with the old mix and filling the spaces with new mix. There is little or no root disturbance and the plant keeps on growing.

Here in the botanical garden, we keep *Nepenthes* in the greenhouse together with orchids and under no circumstances must the pots be allowed to stand in water. Everyday, we spray them and they reward us with beautiful pitchers, leaves and flower almost every year.

Want Ads

Charles L. Powell, II (2932 Sunburst Dr., San Jose, CA 95111)

FOR SALE: Durastill. A small used electric still with 5-gal reservoir (In excellent condition). \$800 new, asking \$250 plus shipping. Produces about 10-gal. a day.

Ernest Taniguchi (45-1040D Wailele Rd., Kaneohe, HI 96744-3153)

WANTED TO BUY: A copy of the out-of-print *Plants to Eat Animals* by J.H. Prince.

Erik Holzapple (105 Hollytree Lane, Simpsonville, SC 29681 USA, Tel. 803/967-7357)

TS: *D. stolonifera compacta* \$5.00; *D. burkeana* \$2.00; *P. primuliflora* \$2.00. WTB: *N. bicalcarata*; *N. rajah*, *D. schizandra*; any *Heliamphora* species; *U. quelchii*, *S. rubra jonesii*, *B. gigantea*. Also a copy of CP of Australia by A. Lowrie, Vol. 1 or 2.

The Flow Table

By Joe Mazrimas

Many of us would like to grow as many types of CP as we can but we are set back by trying to grow plants requiring widely different temperature ranges. Frequently, other problems arise such as trying to grow all these plants in a one-room greenhouse which has a limited temperature range under constant lighting conditions. So, what is a CP grower to do about this? One answer would be to buy another greenhouse set with another temperature range. However, this is an expensive solution and so I would like to describe another method that is economical, simple to build and seems to work very well even in a small space.

This method utilizes a system called the flow table or flow step water fall depending on how it is set up. The materials for this method are:

A large plastic barrel or tank that can hold 20-40 gallons (80-160 liters) of water. A sump pump or submergible pump, plastic pipe (PVC of 3/4 inch diameter), and a bench with 1 inch sides lined with linoleum or thick plastic. The bench is constructed with a slope that drops about 1/4th of an inch per linear foot from the horizontal or level position. If a leveling device is used, about one-half of a bubble from the true level position would be suitable. Instead of a table and where space is limited, one can make a staircase with each stair having a one inch lip and the water now cascades from one stair to the one below.

The water reservoir or barrel is buried in the ground to keep it as cool as possible. The large volume of water is needed to keep the temperature stable even on a hot day. Rain water or distilled water should be used to prevent mineral deposit buildup as the water does evaporate but rather slowly and needs to be replenished from time to time. The sump pump now is used and connected to the piping which in turn pumps the water to the highest point of the table or staircase. Now, the flow must be spread out over the table to be most effective. Several kinds of diffusers can be used but the flow rate will determine the width of the table needed since the cooling effect depends on a well-defined layer of water flowing in and around the pots of CP on the table. This flow of water should be slow and then collected at the lowest end into a pipe that runs back to the top of the reservoir. So, the pump takes the coldest water from the bottom of the tank and eventually this water is used to cool the pots of plants situated on the bench.

The warmer water that is heated by the sun and the temperature of the greenhouse air is returned to the tank to be cooled by the soil in contact with the container walls.

The technique described above has some advantages and disadvantages. On the plus side, plants that require cool day and night temperatures can be grown in strong sunlight without the fear that the soil medium will heat up. The cost of materials and electricity are minimal since many of the items can be made from recyclable materials. The space for this setup is minimal and plants of many genera can be grown together that require similar temperature and light requirements. Plants will also receive a constant and regulated supply of water that should wick up into the pot surface. It seems that highland-type *Nepenthes*, some Mexican *Pinguiculas*, *Darlingtonia* and South African *Droseras* would enjoy this method.

On the negative side, a recyclable water system exposed to sunlight always seems to have problems with algae growth. Perhaps a filtration system placed on the return side consisting of glass wool, sand, and activated charcoal will control this problem. Another potential problem is the spread of water-borne diseases between the pots since they will be in continuous contact over a long period of time. There is not much that could be said about this except that scrupulous methods must be used at all times when

introducing a new plant to the colony. Sterilized soil media should be used and clean conditions should prevail at all times. A fine wire screen should be fastened to the top of the barrel or reservoir to keep out mosquitoes and debris.

Finally, I hope that this method will be tried and that further refinements will be made and published in CPN at a future date.



Flow Table. Photo by B. Stanley

Call for Carnivorous Plants for a New Botanical Garden in Victoria, Australia

By Robert Gassin (43 Frudal Cres., Knoxfield, 3180 Australia)

In 1989, a new botanical garden was opened in Victoria, the southernmost state of mainland Australia. This garden is exclusively for native Australian plants and an area of about 12 m. by 5 m. has been set aside for native CP. This area will be opened to the public in mid 1991. At present, attempts are being made to obtain as many species of native CP as possible, and the help of enthusiasts would be appreciated.

The CP area is a peaty sand flat adjoining a small pond, and there is a sandy slope rising from the flat to a walking track. The flat remains moist throughout the year and part of it is flooded during winter. *Drosera spatulata*, *D. pygmaea* and *Utricularia lateriflora* occur naturally in this small area. The sandy slope rises to about 2 m. above water level and should be suitable for several species of tuberous and pygmy drosera. There are plans for a raised wood walkway to be built across the pond and peaty sand flat to make observation of the plants easier.

My purpose with this project is as an advisor on behalf of the Victoria Carnivorous Plant Society, and also to help obtain plant material for the display. The Garden will only accept plants where the original collection site is known for certain, or direct descendents of plants whose collection site is known (such as plants grown from leaf or root cuttings, gemmae and seed).

The Garden is interested in obtaining as many species and subspecies of Australian native CP as possible in the form of whole plants, cuttings, gemmae or seed. The

help of enthusiasts would be appreciated. Plants must be labelled as to species and/or subspecies (if applicable) as well as much detail as possible regarding origin of the material in the wild. Collection date and collector identity are optional but preferred.

All species of native CP are welcome. However, the following are considered priority: *Byblis gigantea*, *B. liniflora*, *Cephalotus follicularis*, *D. adelae*, *D. menziesii* (all forms), *D. heterophylla*, *D. indica*, *D. macrophylla*, *D. orbiculata*, *D. sp.* 'hammerleg', *D. platypoda*, *D. erythrorhiza*, *D. zonaria*, any pygmy drosera, *U. multifida*, *U. westonii*, *U. volubilis*, *U. menziesii*, *U. hookerii*, *U. simplex*, *U. fulva*, *U. flava*.

All plants received will be entered into the Garden computer making later identification easier. This is an opportunity to contribute to a unique project involving CP, the success of which will largely be determined by plant contributions by us, the CP enthusiasts. Your help would be most appreciated. Naturally, considering import and export regulations of plant material and any plant parts of some restricted species, we would expect the most help from fellow Australians.

Please forward any plant material or queries to me at the above address, or telephone (home (03) 763-9148, (work) (03) 725-9011.

Carnivorous Plants of the Bogong High Plains

By Robert Gassin (43 Frudal Cress., Knoxfield, Australia 3180)

In the first week of March, 1990, A fellow CP grower from Melbourne and myself ventured to the Bogong High Plains for two days of bush walking.

The Bogong High Plains is part of the Bogong National Park, an alpine reserve 350 km north of Melbourne. It is well known for its magnificent natural display of native alpine flowers in summer, and cross country skiing in winter. The High Plains are about 1600 m to 1800 m above sea level and are covered in snow from June through September or October. In spring, the snow melts to reveal typical Australian alpine plant communities including open and closed heathlands, tussock grassland, large strands of the beautiful snowgums, and of particular interest to CP enthusiasts, alpine bogs bordering natural springs and pretty winding fast flowing streams teeming with trout.

The main aim of our trip was to photograph and film the CP's native to this area. There have been three species found on the High Plains: The common alpine sundew *Drosera arcturi*, the very rare and attractive Tasmanian bladderwort *Utricularia monanthos*, and an even rarer summer growing tuberous sundew of uncertain taxonomy, which to the best of our knowledge and been discovered two years earlier by Nick Collins, another member of our local CP society.

Our search started out on a high note as we found both *D. arcturi* and *U. monanthos* in the first bog we explored. (There are hundreds of alpine bogs in this park). Both these species were found within 50 m of the roadside at an altitude of 1080 m. Thousands of *D. arcturi* plants were found in deep sphagnum beds and wet sandy clay soil along the banks of small streams. Each plant had 3-4 leaves up to 7.5 cm long. They had flowered 2-3 months previously and their dried, blackened seedpods were full of seed. *U. monanthos* occurred along the banks of the same stream but only over an area of 10 m by 20 m. It grew in both shallow sphagnum beds and wet sandy clay soil. This species was in flower bearing very pretty deep purple flowers with two yellow stripes on the palate, on a peduncle up to 3 cm tall. Over the next two days we explored several other bogs; large colonies of *D. arcturi* were found in each of these but we did not locate another colony of *U. monanthos*.

The tuberous *drosera* we were hoping to find occurs at about 1800 m altitude in a remote part of the park 10 km from the nearest road. We set out early the second morning of our visit and after a brisk two hour walk which included escalating two mountains, we finally reached our destination. After exploring for about 15-20 minutes, we eventually found the plant we had been looking for. Much to our surprise, it occurred in very boggy ground and in shallow, wet sphagnum beds (Tuberous *droseras* usually grow in relatively dry soil). The plants were in flower and looked like small *D. peltata*. They were bright red in colour, each had a basal rosette about 2 cm in diameter and an erect stem (rarely two) up to 20 cm tall. Leaves were shield shaped and borne singly and alternately along the stem. The sepals were dark green and pubescent and the petals were white. Due to the overcast conditions the flowers were not open. Most tubers were within 3 cm of the soil surface and were up to .25 cm in diameter. An interesting feature of this plant is the presence of what appears to be adventitious roots arising from the vertical stolon. A few specimens were collected for taxonomic study.

After two days of fruitful exploration, we headed back to Melbourne with a few questions to ponder: Would this alpine tuberous *drosera* revert to a summer dormancy/winter growth pattern in the Melbourne climate? Would refrigeration of tubers of other *droseras* during dormancy be a viable way to protect them from complete desiccation, rot and/or disease? And finally, would not some tuberous *droseras* grow better in summer in the colder climates of Canada and northern Europe?

'New' Potting Medium

Alexander Mrkvicka (Hoplfergasse 6/16/1/4 1230 Vienna) sent in the following information about a "new" potting medium that he has been using for CP. "New" is in quotes because the material has been used by European orchid growers for some years. It is called **rockwool** and is manufactured from volcanic rock. Instead of being "puffed" like perlite, it is melted and spun into a material much like glasswool as used for insulation.

The advantages he has found in the medium are several. The material is stable and open and plants may be kept in it for years, resulting in less root disturbance from frequent repotting as required in some other media. The medium is chemically inert and nutrient-free, and the horticultural variety has a pH of 5.5. Salt accumulations are easily removed with a pure water rinse. Water is held to Rockwool in large amounts, but there are ample humid air spaces for healthy roots. The material does not support pests (crawling or moss), and does not compete with the potted plant as live sphagnum can. Due to the white surface and porous spaces, soil temps can be kept low (e.g. for *Darlingtonia*).

A few disadvantages are present. One must specify horticultural grade as mentioned above. The medium requires more fertilizer applications where these are used since it drains so well. The color (light grey to white) does not look like soil.

He has been growing *Sarracenia* spp., *Darlingtonia*, European *Pinguicula*, *Nepenthes*, some "easy" *droseras* and terrestrial *utricularias* with good success. *Pinguiculas* and *nepenthes* benefit especially from fewer repottings and foot disturbance. Seedlings and mature plants sensitive to salts accumulation are easily managed by the relatively fewer rinses of pure water required to clear the medium. He feels that the *marl* fen plants he grows such as *Drosera linearis* and *Sarracenia purpurea* ssp. *purpurea* do especially well with fewer phenotypic changes than when grown in peat or sphagnum.

He cautions that one be careful when handling dry rockwool since the dust is irritating and the fibers can penetrate skin—use gloves when handling.

(Editorial Note: The following does not constitute an endorsement or implication that it is the only source, but in the United States we have found that OFE International Inc., P.O. Box 164402, Miami, FL 33116, a dealer in orchid growing supplies, does supply horticultural rockwool. They have a water absorbent and a water repellant form, the latter for particularly fast drainage. They also supply mixes of these two forms in various proportions. We assume that Alex was discussing the absorbent form).

See other references to the use of rockwool on page 75 (Nepenthes & Rockwool by Freddy De Coninck.

Sarracenia purpurea ssp. *venosa* growing in rockwool (left). Photo by A. Mrkvicka.



Drosera sp. "Hammersley" **Another New Drosera Species from** **Western Australia**

By Phill Mann, 16 Osborne Rd., Mt. Barker 6324, West Australia

The search for new Carnivorous plants from little known territory of our vast state is always quite exciting because the possibility of locating another new species is quite possible.

Such was one trip in July 1989 to the south coastal region where while checking a damp creek bed I located what looked at first to be a *Drosera macrophylla* type, but this species occurs some 360 miles (600 kilometres) farther to the northwest.

Closer inspection revealed that this plant had finished flowering and did not fully compare with any of the other known species. The plant had almost completed its winter growth so another would be necessary earlier in the season of the next year.

In May 1990 I revisited the area with Alan Lowrie. We were greeted by one of the most exciting sights I have seen. The area where I had located this plant last year was of semi-thick bush type with Eucalyptus, *Dryandra*, *Banksia* and *Hakea*. This growth had made it impossible to see more than a few meters into the area. Now it was bare except for the few remaining trees after having suffered a very severe bushfire that had burned everything on ground level but a small amount of leaf litter.

Scattered everywhere were clumps of bright white flowers and the more I looked the more plants I saw. *D. sp* "Hammersley" was flowering in the thousands.

Drosera sp "Hammersley" roughly resembles a cross of *Drosera bulbosa* and *Drosera macrophylla*, but unlike *D. bulbosa* this plant is multi-flowered. One (photo 1) had 108 flowers and buds. Mass flowering in such proportions would be attributed to the bushfire the previous summer and typical of tuberous drosera in this situation.

Drosera sp "Hammersley" first appears as a bud followed by flowering scapes, unlike *D. macrophylla* which presents leaves first followed by flowers. These flowering scapes are several and multi-branches. The flowers are heavily perfumed and last several days, closing each night. The scapes can reach a height of 6-10 cm and as the first flowers finish, it then becomes prostrate but has the ability to raise the remaining flowers above the ground as they open, (see Photo 2).

The leaves appear when flowering is nearly completed; the plants then seem to put all their effort into producing a beautiful rosette of long, slightly obovate leaves, up to 7 cm long. Meanwhile, the fruiting scapes have been covered by this rosette of leaves and it appears that the fresh seed germinates readily from beneath the leaves. The leaves have a raised mid rib similar to *D. bulbosa* and they have a coppery orange to red colour.

Another obvious difference with *D. sp* "Hammersley" is that the bulbs of this plant are a distinct sphere in shape, whereas *D. bulbosa* is a tear drop shape and *D. macrophylla* is oval.

Altogether, with the massed flowering of the multi-branched scapes, vivid white flowers that are highly perfumed and open for several days, red tinged leaves of the medium to large rosette—this plant would have to be considered as the best of the rosetted tuberous *drosera*.

The name *Drosera* sp "Hammersley" relates (as with other field named species), roughly to the area where these plants are found. These names are used mainly to enable us to relate to these different unnamed species. Care should be used when using these names as they do not apply to type locations. On some occasions names such as this have been deleted and substituted with numbers by some collectors. This only creates some false species and considerable confusion.



Photo 1. *D. 'Hammersley'* in full flower.



Photo 2. See text for details.



Photo 3. *D. 'Hammersley'* in full flower.
Photographed in habitat by author.

Carnivorous Plants of Australia: Volume Two

By Allen Lowrie, XXXVII, 202 pp, 170 colour plates and 56 full-page drawings. University of Western Australia Press, Nedlangs, W. Australia, 1989. ISBN 0 85564 300 5

Prices from local agents: International Specialized Book Services Inc., P.O. Box 1632, Beaverton, Oregon 97075 (U.S.A.); Peter Moore, P.O. Box 66, 200a Perne Rd., Cambridge CB1 3PD (Europe); Melbourne Univ. Press, Carlton south, Vic. 3053

Review by Martin Cheek

The second of three volumes, this follows very closely the format of the first volume devoted to tuberous sundews (1987- for review see C.P.N. 17:27). This book contains the rest of the Western Australian sundews—mostly pygmies, but also *D. glanduligera*, *D. hamiltonii* and three additional sorts of tuberous sundew, which presumably have only recently come to light. Northern Territory and Queensland sundews e.g. *D. adaelae* have been omitted and we must await them, with *Utricularia*, *Nepenthes*, *Cephalotus* and *Byblis* in the final volume.

The Pygmy Sundew Manual would be a good sub-title for this book. It certainly puts every other work on the subject into the shade. Each species and sub-species is usually treated to 4 pages: the first a full-page description, the second of detailed line drawings, the third a distribution map, the fourth of 2-6 color plates. The introductory pages give a three page glossary of the botanical words used and an illustration of the basic parts of a pygmy sundew, then a list of the species arranged by the pygmy species. Gemmae are then treated to 16 pages, largely of very clear pencil drawings which illustrate each species and with a separate key to the species based on gemmae characteristics. There follow pages entitled 'how to identify a pygmy sundew', 'the life cycle of a pygmy sundew' and 'habitats'. While first does not address the subject and contains information repeated elsewhere, the information on 'life-cycle' and 'habitat' make excellent reading and will be very useful to those who wish to know more about the



Figure 1. The type of *Drosera omissa* Diels at the Berlin herbarium.

line refers to 'rosette loosely open': the opposite character state! Furthermore, in couplet 9, the upper line finishes 'inflorescence 1 to 2.5 cm long, peduncles 1- to 2- flowered'. Whilst the lower reads 'inflorescence 2.5 cm long, peduncles 1- to 8- flowered'. In couplet 4 'flowers large' is contrasted with 'flowers small'. The latter two couplets are hardly diagnostic! How for example does one know whether a flower 1 cm across is 'large' or 'small'? In couplet 35, 'inflorescence' is mistakenly printed instead of 'pedicel' in both leads. In testing the key, it generally worked well, but not all material keyed out—I got nowhere with the plant widely in cultivation as 'Warriup', for example. The descriptions, whilst complete, do not have ranges for many measurements. All too often we are presented with 'petals 6 mm', when 'petals 5-7.5 mm' would be more appropriate. Whilst the descriptions are remarkably comprehensive, no mention is made of inflorescence bracts which do vary from one species to another, while the phrase "A fibrous-rooted plant" which starts every description seems wasted since every one of the 39 or so pygmy taxa has this character—this phrase would be better employed in the general description for sect. *Lamprolepis* and omitted from the species descriptions. Twenty pages could also be saved by employing maps suited to the phytogeography of the pygmy sundews—all but one are restricted to the bottom third of the map employed—the upper two-thirds (half a page) being put to no good purpose—39 times! Species with long peduncles are often mis-represented with truncated and abbreviated versions in the line drawings—misleading. Better, I feel, to have adopted the practice of volume 1 in this matter.

For the grower of pygmy *Drosera*, a major disappointment is that the numerous cultivar names that so many pygmy sundew species, of direct wild origin, have been traded under for 10 years or more, such as 'Muchea Pink', 'Gidgeganup' and 'Bannister', are not accounted for, nor mentioned anywhere in the text.

Whereas Neville Marchant and Alex George in *Flora Australia* volume 8 list 13 species of pygmy sundew, Allen Lowrie lists 31 species, 3 of which are split into a total of 8 subspecies. Where have all the new species come from? Undoubtedly, the strikingly

ecology of the plants they grow. It explains much about the differing cultural requirements of different species. Finally, there are interesting chapters entitled 'Early Swan River Collections' and 'Hybrids'.

As is often the case with glossaries, some of the definitions here are not very illuminating: those for the characters 'Dentate', 'Elliptic' and 'Scape' do not give the features that distinguish these from other character states such as serrate or ovate, respectively. A scape is here defined only as a 'flowering stem', but in fact it is a very particular sort of flowering stem, one that is leafless and arises directly from the ground. This woolliness has unfortunate consequences in the descriptions that follow. For example, strictly speaking, *D. barbigera* does not have a scape as is claimed!

The main key could also be improved. The second couplet would read better if written: 2: Leaves in a basal rosette 3; 2: Leaves scattered along short aerial stem . . . 7.

Since, as presently expressed, couplet 9 follows very awkwardly; although it keys on from rosette compact in couplet 2, one

novel ones are the result of years of searching the wilds of Western Australia by the intrepid band of the author and his colleagues Steve Rose and Phil Mann, but others are clearly 'splits' of what was considered to be the variable *D. leucoblasta* Benth. Are *Drosera closterostigma* and *Drosera helodes* really distinct at species level? We must, I feel, trust to the author. No one can be more familiar than he with these plants. Most unfortunately, the new taxa are not given valid species names, but merely ones attributed to Marchant. This occurred extensively in the first volume—more than 2 years ago—and still the names have not been validated. As things stand now, it is possible for anyone following the International Code to give a different yet botanically correct name to any of the 30 or 40 new taxa informally described in these books. Sadly, it is quite possible that these names will change for this reason in the foreseeable future. Indeed, only months before receiving this book for review from the author. I had myself submitted for publication a paper in which I have the botanical name *D. mannii* to the plant long known in cultivation (since at least 1977) as *D. 'Bannister'*.

In the case of existing, established names, it is often very difficult for an isolated individual such as Mr. Lowrie to establish solely from the original authors' description (presumably all that is available to him) exactly which plant Diels or Planchon for example, were naming as new species in the last century. The descriptions were sufficient to clearly distinguish the plants then, but with subsequent discoveries of new, similar taxa, those descriptions inevitably become more ambiguous. The result is that today, a Diels description might fit several taxa, and so it is sometimes difficult to be certain to which one of these his name applies. In such cases as this, it is imperative to inspect type specimens before applying names. I was most impressed, at first, by Lowrie's tale of the misapplication of the name of *D. omissa* Diels to various taxa by the authors Erickson and Marchant successively, also by his analysis of Diels' monograph and the final solving of the 'almost endless saga'—until I realized that there was no reference to the critical stage of inspection of a type specimen. In the 'nitidula' complex, the characters of the fruiting calyx are of great importance, so I was surprised, on examining a photograph at the Kew herbarium of the holotype of *Drosera omissa* (see Fig. 1) to find that the calyx structure was clearly not remotely similar to the plant he claims is the 'true' *D. omissa*. The saga of *Drosera omissa* continues!

This is a very useful book for, despite the criticisms above, it contains so much that is new about pygmy sundews. At last, the existence of hybrids in this group has been established. The identity of 'Lake Badgerup' is finally revealed as a cross between *D. occidentalis* and *D. nitidula* s.l.—this explains the exceptional vigour of the plant and a great deal else. The difference in timing of dormancy, gemmae production and flowering seen in different species is now explained by the greatly different ecological niches that they are restricted to. Even in view of the reservations expressed above, the keys, descriptions, maps and illustrations are vastly superior to those of previous authors. The works of Erickson and Marchant & George must now be considered completely out-of-date. As with the first volume (still in print), this book is well produced with few typographical errors and a pleasing layout. The illustrations, especially the line drawings, have reproduced very well, and if the pricing is similar to that of volume 1, this book must be considered very cheap and a must for the library of every lover of sundews.

Want Ad

Gregory Lum (510 Lansdale Ave., San Francisco, CA 94127 USA)

WB: *Biovularia Drosophyllum*, *Genlisia*, *Polypompholyx*, fresh cuttings/plants of *Nepenthes madagascariensis*, *N. macfarlanei*, *N. gracillima*, *N. alata*, *N. villosa*, *N. lowei* and *N. boissiensis rubra*.

Taking Close-up Pictures of Your Plants: Part I

By Barry Meyers-Rice (Steward Observatory, University of Arizona, Tucson, AZ 85721, DUNWICH@solpl.as.arizona.edu)

There have probably been many times that something exciting happened in your CP collection that you would have liked to record; perhaps a *Drosera* in full growth, a delicately coloured *Utricularia* flower, or a richly painted *Dionaea* trap. A good close-up picture of your plant would have been an ideal way to capture the event, but you might not have known how to take one.

Common misconceptions are that conventional camera lenses cannot achieve the magnification necessary to capture fine details on our often small CP subjects, that to take close-up pictures of plants requires expensive equipment, and that the photographer has to become versed in complex and arcane technical terminology. Fortunately all of these ideas are wrong. If you are daunted because this article looks long, it is because it treats the subject in detail, and not because the topic is difficult. If you have access to an SLR camera and a tripod, you are probably much closer to taking close-up pictures than you think. The additional equipment needed to convert your camera to this purpose is relatively inexpensive. You can also take close-up pictures in 3-D, using the method described by Tilbrooke (CPN 17:4, p110), except that the distance you should move your camera between pictures should be very small.

To get started, there are four common ways to take high magnification pictures. They are all ways of enabling the camera to focus on much closer subjects than the camera could before, so the size of the image on the film will be larger. The first methods are by using special "macro" lenses that are designed to take high magnification pictures, or even to use "bellows." These options are expensive, and so let's disregard them. The second method is to attach inexpensive "close-up" glass lenses to the front of a normal camera lens. These magnify the image, but they also degrade it so that the result is not always very good. Fine camera lenses are designed very carefully with many glass elements to correct for optical distortions. Close-up lenses are not as complex, and the result is an inferior image. Because of this, these lenses should be used only for low magnifications. The third way is through something called a "reversing ring" which is useful especially if you are planning on taking pictures with magnifications greater than about 1x. A reversing ring is also the cheapest way to do close-up photography. However, if used by itself it only gives you one magnification to play with. I will discuss reversing rings briefly, but I will concentrate on the fourth method, the use of "extension tubes."

Extension tubes (I will just call them tubes) are very versatile. They can be used with any of your camera lenses. They come in different lengths, and can even be used together to make new extension lengths, to give you a wide variety of magnifications from which to choose. A tube is just a metal ring that mounts as a spacer between your camera lens and camera body. The bigger the spacing (or extension), the greater the magnification.

Since it has no glass lenses, it does not degrade the image. The cost for tubes depends upon what kind of camera you have, and the details of the frills you decide to get with them, but they are not too expensive. For example, a new set of three different tubes for a Pentax camera may cost about \$70 (USA). The best thing to do is to buy them second hand since there are no lenses that might be scratched, and a used set costs a fraction of what a new set does. There is a lot of used camera equipment available—check the yellow pages or a camera club to find it.

A typical set of tubes includes tubes of three different sizes. The sizes of my tubes are about 10, 20, and 30 mm. This size is the distance that the lens is held in front of

its normal mounting position. In addition to your tubes and camera body, you need a camera lens. In this article I'll discuss using a standard 50 mm lens. We will use sunlight as the light source because it is bright and cheap. You'll also need film. For the best images, a slide film like Kodachrome 64 is excellent. If you use a "faster" film, like Kodachrome 200, the pictures will look grainier. I use slide film instead of print film because it is cheaper to buy and develop a roll of slide film than it is with colour print film. The last important item you'll need is patience. Remember at the start that you will make mistakes, but you will also be rewarded with successes.

As soon as you get your tubes, just play with them for a while to become familiar with them. When you put a 10 mm tube on a 50 mm lens on your camera, one of the first things that you'll notice is that focusing your camera is different. When you're using tubes, you focus the camera by moving the camera nearer or farther from the subject—at most the camera lens focusing ring is a fine adjustment. You'll also notice that the distance from the camera to the subject is much smaller now that you're using a tube. With a 10 mm tube, my 50 mm lens gives me a very nice view of a large *S. flava* flower, at a focusing distance of about 7.5 inches. With a 30 mm tube, the subject distance is smaller (about 3.5 inches), and a flower of *S. rubra* nicely fills the viewfinder. Using 60 mm of extension (all three tubes at once), I have difficulty fitting all of a *D. capensis* flower (at a focusing distance of less than 2 inches) in the viewfinder! To estimate the magnification of your lens/tube combination, divide the extension length by the focal length of the lens you are using. That estimate is exact if you set the focusing ring on your lens to infinity while focusing. For example, if I use a 30 mm tube with a 50 mm lens, I'll have a magnification of $30/50 = 3/5x$. In other words, a leaf 10 mm long would produce an image on the slide that is 6 mm long ($3/5 \times 10 \text{ mm} = 6 \text{ mm}$). Make a print of that slide, or project it on the wall, and the result is something much bigger than life. Strictly speaking, if you are taking pictures with a magnification greater than 1, then you are doing *macrophotography*. It is easy to get magnification crazy, but there's not much point to it. Once a *Sarracenia* petal completely fills the field of view, you don't get anything new by continuing to magnify it. Past that limit is called "empty magnification."

After all that introductory information, the best way to get some experience with closeup photography is to take some pictures of your first subject. As an easy first candidate I chose a cluster of *D. rotundifolia* hibernacula (Figure 1). The plant was completely flat against the soil in its pot, so I opted for an overhead shot instead of a profile. Experimenting with my tubes, I decided that using the 20 and 30 mm tubes together (50 mm of extension) was nice—it framed the dormant plant well, included some background *Sphagnum* and previous season's leaves, and generally pleased me. Then I had to do a bit of clean-up, pushing back obtrusive *Sphagnum*, weeds, or whatever else that I thought would detract from the final picture. After these preliminaries, I positioned the pot and camera so that the subject was in good focus and was framed well in the viewfinder. I kept in mind the following factors:

- 1) The subject must have the sun shining on it as directly or brightly as possible. Shadows from parts of the subject, camera, or you, should be avoided.
- 2) The camera and the subject both must be very steady. Do not try to hand-hold your camera. A tripod and a shutter release cable help keep vibrations to a minimum. Most consider these two items essential.
- 3) The finished picture from a camera usually includes a slightly bigger field of view than is visible in your viewfinder. Is something annoying (like a name tag) just out of the field of view? It might appear in the final picture.

In this example, I satisfied these considerations by laying the pot on its side and keeping the camera (held in a tripod) level. The hibernacula were strongly illuminated, and the camera's shadow fell off to the right. Focusing is the next step and it can be

tricky. When you're ready to take an exposure, look through the viewfinder critically and think about the focus. Perhaps your subject is in focus, but what about the rest of the soil surface? If the pot is facing the camera at a crooked angle, large areas of the view will be slightly farther from (or closer to) you, and will appear out of focus. Straighten that pot out—it will pay off in the end. Set the "f/ratio" of your camera to around f/5.6 (I'll discuss f/ratios in detail in Part II). On the sunny day I did this, my camera's light meter told me that I needed a 1/30 second exposure. A final check on focus, shadows, and composition (all OK), and I took a picture. Not being overly confident, I set my camera to manual mode and also took pictures at 1/15 and 1/60 second exposures. This is called "bracketting," and is a wise precaution if you are unsure if you want to believe your camera's light meter. Since slides do not duplicate well, if you want extra copies you should take them now. Look at the final picture (Figure 1) critically to see what could have been improved. The composition is OK, but not astonishing. The smaller hibernaculum is covered by a dying leaf—if I had moved the leaf aside the picture would have more to offer. There are no interesting subjects cut in half by the edge of the slide, which is good. The sharpness of focus on the large hibernaculum is very good (on the original slide), but the smaller hibernaculum is somewhat out of focus. Later I'll talk about how this could have been avoided. It is important that you record the camera lens, extension, exposure time and f/ratio combination that you use, especially when you're starting out so that you can later figure out what went wrong/right.

A large number of steps to take this picture? Not really. Take a few pictures and it becomes second nature. You can use these steps to photograph the whole range of ground hugging *Drosera*, *Pinguicula*, and other CPs in your collection.

Now we'll try a different kind of subject. A friend sent me a clump of *U. graminifolia*. When it first flowered I pulled out my camera. A tall, erect inflorescence is best captured by a profile shot instead of from straight overhead. Since the flower was only about 15 mm long, I decided on using 60 mm of extension to magnify the flower greatly. I positioned the flower and scape so that they were both in sharp focus. If the background in side shots is very busy and complex, the plant will be camouflaged and the impact and value of the photograph will be much reduced. This is a chief difficulty with field shots of plants. You can remedy this problem by hanging a uniformly coloured fabric a few feet behind the subject. I used a piece of black velour (which doubles as a robe when I'm not taking pictures) in the background. I like black, because it offers a great deal of contrast and makes the plant appear to pop out more—Don Schnell frequently used a grey card background in his CP book (i.e. *Dionaea* on p17.) The tuberous *Drosera* in Allen Lowrie's first book were often growing on white sand—producing the same effect.

After positioning the subject and checking the focus and backdrop, I set the f/ratio to f/11, and my camera's light meter (back on automatic) indicated an exposure of 1/4 second. I waited for the wind to die down so the scape stopped waving around, and took some exposures. The results were good (Figure 2), with an excellent focus on the flower and the scape—it would have been easy to forget about the scape. The black background is a bold contrast to the flower. When I got my pictures back from the lab, I noticed that the 1/4 second exposures looked slightly overexposed. In contrast, the 1/8 second picture (that I took because I bracketted) was properly exposed, and the colours were richer and less burnt out ("saturated"). The camera's light meter was fooled because it calculated the exposure needed to correctly expose the *entire* picture. Since the only light entering the camera was from a flower that filled barely a fraction of the view, with black background filling in the rest, the camera computed an average exposure that was too long. The result was a subject which was slightly overexposed. Fortunately I was saved by bracketting, but you can anticipate this happening and

save film. In fact, I bracketted at 1/4, 1/8, and 1/16 seconds. If I had used a grey card background, this compensation would not have been necessary.

Tips: When you are faced with subjects that are at the end of a long spindly scape (like the one in Figure 2), there must be no wind or else the picture will be blurred by motion. I find that it's worth my while to work indoors on shots like these, using light streaming through a window. Also, when you take your exposures, if you pull your head away from the camera, light can leak in through the viewfinder and trick the light meter into underexposing your picture. Keep your eye near the camera or cover the viewfinder opening.

Now it's your turn to try your hand at taking some pictures. In part II of this article, I will discuss close-up photography with telephoto lenses and the value of reversing rings. I will also explain the significance of the *f*/ratio you shoot at. Until then, take your pictures using large *f*/ratios (like around *f*/8—*f*/16).



Figure 1. *D. rotundifolia hibernacula*



Figure 2. *U. graminifolia*

Taking Close-up Pictures of Your Plants: Part II

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In part I of this article, I discussed the ins and outs of extension tubes, magnification, the values of bracketting, and how to take pictures of plants from straight overhead and from the side. In this article I will finish your introduction to close-up photography with some words on the all important “depth of field,” as well as on telephoto lenses, reversing rings, and picture composition.

The f /ratio at which you take your pictures is very important. If you use an f /ratio like f /1.4 or f /2.0 you are letting a great deal of light into your camera, and so your exposures will be shorter—minimizing the chances of the subject moving during the exposure and blurring the picture. However, it is much better to make sure that both camera and subject are stationary, and wait for a windless moment to shoot at an f /ratio like f /16. The reason for this is that you get a much greater “depth of field” with these f /ratios. Depth of field measures how far in front of or behind the main subject an object will still be in acceptably good focus. Getting an adequate depth of field is arguably the most important thing to consider when you are framing your shots. In everyday life, your eyes are constantly refocusing as you look at things at different distances, so you tend to take depth of field for granted. In each photo you have to choose only one and so you should pick the best you can. You set the depth of field by focusing and by setting the f /ratio to as large as you can. For example, with a 50 mm lens and 50 mm of extension, my depth of field at f /1.4 is 0.6 cm ($1/4$ inches), at f /8 it is 1.4 cm (0.6 inches), and at f /22 it is 2.5 cm (1 inch). In practice, you should avoid the highest f /ratio of your camera because the image is slightly degraded because of diffraction effects. My 50 mm lens can shoot at f /22, but I usually shoot at f /16. With some cameras or tubes, when you set the f /ratio to a high value like f /16, what you see through the camera viewfinder becomes faint. If so, you’ll probably find it easier to focus at an f /ratio like f /2.0 and then return to the f /ratio for your picture. The photograph of the *D. rotundifolia* that was discussed in part I of this article would have been better if I had used a larger f /ratio—the second hibernaculum would have been in better focus. When I took care to keep the soil surface square with the camera lens I was ensuring that the entire image would at least be at the same focus. In other words, the soil surface was at the “plane of focus.”

Using this information about f /ratios, let’s try a shot that requires a large depth of field. I wanted to take a series of pictures of CPs, evoking how they might look from an insect’s perspective. My first try was with a *S. psittacina* pitcher. With 50 mm of extension, I found that I had to snip the pitcher off the plant and anchor it in a pot so I could get at it from the angle that I wanted. Even then it took me a while to get the lighting right so the pitcher was well illuminated and didn’t have any deep shadows in bad places. As a trick during the exposure, I held a peanut-sized piece of white styrofoam on a toothpick behind the pitcher. This ensured that the fenestrations on the backside of the globose hood would light up. Since this was a difficult shot I bracketted at several exposure and f /ratio combinations, refocusing at each shot. The best (Figure 1) was at f /16 and has a pretty good depth of field. The foreground just starts to lose its focus but it is not too objectionable. The backside of the hood (seen through the opening) is also slightly out of focus, but in this case is helpful as it establishes that as a background surface farther in the distance.

The *Sarracenia* picture illustrated that a small depth of field can actually be used to your advantage. Having some picture elements appear slightly out of focus can create an illusion of depth in your photos. Figure 2 is a photo of *B. liniflora* that has

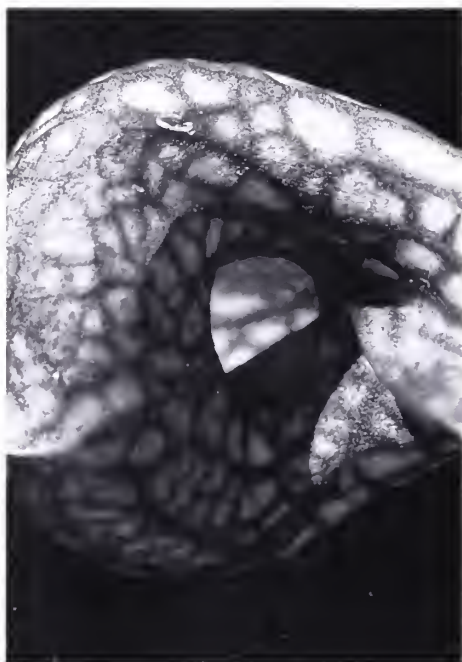


Figure 1. *S. psittacina*

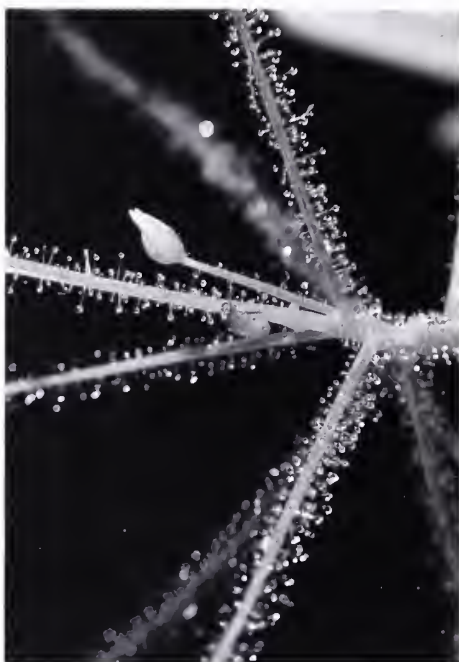


Figure 2. *B. liniflora* and gnat

a degree of 3-dimensionality because of the depth of field. It was taken with 50 mm extension at $f/11$. In the foreground and background the leaves defocus, while on the stem a gnat is in good focus. In this example having the foreground noticeably out of focus worked, but it is usually better to have only background objects out of focus. The main flaw in this picture is that I included a bit of a white name tag (which wasn't visible in the viewfinder). A small depth of field can also be used to your advantage when you are composing your shot. Intentionally having some objects extremely out of focus smears them out beyond recognition or even to the point that they disappear entirely. For example, in his recent CPN article (18:3, p79), Don Schnell's photos of *Sarracenia* work against a busy background because the irrelevant background is very blurred. If the background was in focus, the plant of interest would be lost in the confusion. This is a technique that comes with practice, and should be used by field photographers more than it is. In overhead shots of *Drosera*, a vertical scape that you might not want in your picture can be blurred to invisibility by using a small f /ratio.

Until now, I've restricted this discussion to short-focus lenses (such as 50 mm). If you have a telephoto lens you should certainly use that in your close-up work too. Since telephoto lenses have much longer focal lengths than short-focus lenses, a given length of extension results in less magnification. Then why use them? The chief advantage is that with telephoto lenses the distance from the camera to the plant is usually a few to several feet (instead of inches!) and the depth of field is proportionally bigger, too. If a particular close-up shot calls for a depth of field of a few inches or more, a telephoto lens is the way to go. The low magnification is usually not a disadvantage because if your subject (perhaps a thick clump of *U. sandersonii* flowers) is three inches in depth, it is probably comparably large in breadth as well, and you would need a low power to fit them all in the picture anyway! Telephotos are particularly well suited for taking portraits of *Sarracenia* and *Nepenthes* pitchers and flowers.

Figure 3 is a picture that I took of a *P. primuliflora* specimen the day before its blossom opened. I was interested in the way that the developing flower and the plant



Figure 3. *P. primuliflora*

appeared as a whole, and I decided to photograph it in profile. From this perspective the plant evoked for me the image of a swan, viking ship, or mythical sea monster navigating a body of water. Since I needed a depth of field of at least two inches, I used my 135 mm telephoto at $f/22$ with 60 mm of extension. The background was black cloth. Since the depth of field was great, flecks of lint or dirt on this cloth were likely to be visible, so I took care that it was clean. The camera indicated an exposure between $1/2$ and 1 second and I took several pictures at slightly different exposures—the best was at $1/2$ second. I was particularly careful about the exposure time on this picture because the blossom was almost pure white (with just the faintest hint of blue) and if the picture was overexposed the blossom would look burnt out, and if underexposed it would look dull grey. The colour of pure white subjects like this blossom can be shifted by their sur-

roundings. When I was taking this picture, I was perplexed by an mysterious red sheen that I kept seeing on the petals, until I realized that it was catching glare from the red shirt I was wearing. I put on a white shirt. The delicate colours of translucent subjects such as this can be the most challenging to capture faithfully.

To round out your introduction to close-up photography, here are a few more tips to help you produce top notch photographs. Camera lenses are designed to work their best when the distance from lens to subject is larger than the distance from lens to film, but when you're taking high power shots (1 x or more) with tubes, you violate this design assumption. So it is wise to use a "reversing ring," which is an adapter that lets you mount your camera lens on to your camera backwards. The advantage with this is that you can do macrophotography with the subject at a distance of several inches from the camera. Not only does your lens produce better images, but you will also have a greater depth of field, and fewer cases of sundew goo on your lens. You can also use a reversing ring with tubes to produce extremely high power images, but you will have to use strong artificial lighting to avoid very long exposure times (incidentally, "bellows" are just expensive, adjustable tubes combined with a reversing ring).

A word on photographic style—be inventive. A cleverly framed shot can be dramatic or even humorous as well as illustrative and informative. While a *D. binata* plant might photograph well in profile, angling the camera so that it points upward slightly can transform the plant into something almost tree-like in appearance. Avoid framing a subject in the exact center of the picture. This produces a static, lifeless product—the origin of the term "dead center." If your intended picture would include a lot of plastic edges of a pot in the frame, submerge and hide the pot in a larger container filled with a similar planting medium to produce a more attractive photo.

Try the methods I've discussed and tricks of your own devising to take all sorts of excellent photos of your own small CPs. Experiment with your camera—since the resolving power of your camera is greater than that of the human eye, you're guaranteed to see things you couldn't see before. If you are interested in learning more

about close-up photography, a fine book to read is Basic Guide to Close-up Photography (HP Books). There is also a good article on inexpensive lighting tricks, even for use in the field, called Low-Tech Macro Lighting in the April 1990 issue of PHOTOgraphic Magazine (a U.S. based magazine that may be archived at your local library). I am also willing to discuss further macrophotography hints and troubleshooting with other growers—my address is in the 1989 ICPS directory.

More On The Evolution Of Drosera

By John D. Degreef (6 rue Libotte; B-4020 LIEGE; BELGIUM)

Professor S.E. Williams has kindly drawn my attention to a pollen study by TAKAHASHI & SOHMA (1982), which contains valuable information on the evolution of the genus *Drosera*. Results can be summarized as follows:

1. The primitive sections **Psychophila** (*D. uniflora*, *D. arcturi*, *D. stenopetala*) and *Drosera* are closely related.

2. Some sections still clearly show that they derive from these:

-the African section **Ptycnostigma** (*D. cistiflora* e.a.)

-the sundews from the mildest regions of Australia: *d. hamiltonii*, section **Arachnopus** (*D. indica*, *D. adelae*...), and to a certain extent, *D. banksii*. The link between section **Drosera** and *D. hamiltonii* is rather surprising considering the floral differences. Yet the presence of the naphthoquinone plumbagin in this now appears less strange. The fact that a primitive member of the subgenus *Ergaleium*, *D. banksii* has pollen resembling that of section **Drosera**, is extremely important information. It confirms that the modern tropical or subtropical tuberous sundews can indeed be descendants of Antarctic immigrants.

3. There are definite links between the advanced Australian *Drosera*:

-the close relation between the tuber-producing sections **Erythrorrhiza** and **Ergaleium** is confirmed.

-these two are relatives of section **Phycopsis** (*D. binata*), section **Lamprolepis** (pygmies), *D. pygmaea*, and quite surprisingly, *D. petiolaris*. Until now the latter was considered as a very close reeelative of section **Drosera**, not as intermediate between this group and subgenus *Ergaleium*!

4. There were faint indications that *D. glanduligera* was related to the tuberous sundews. This study shows an affinity with section **Thelocalyx** (*D. burmanni*) instead! This section does not appear to be close to section **Drosera**. *D. glanduligera* is much more different from the South American member of this group, *D. sessilifolia*, than *D. burmanni*. So we have to allow for a much longer evolution, and the migration of these plants to Australia need not be as recent as hypothesized earlier.

5. *D. regia* appears not to be related to any known section. Its pollen somewhat resembles that of... *Dionaea*! This is very important information, for we may have found the last palynological link between the modern *Drosera* and the archaic Fischeripollis, from which the sundews (and the Venus' Flytrap) may descend! The rather primitive flower of *D. regia* does not oppose this interpretation.

6. There are may abnormal pollen grains in some plants of *D. binata*. This confirms the heteroploid nature of this species.

Source:

TAKAHISHI, Hideki & SOHMA, Kankichi. (1982). Pollen morphology of the **Droseraceae** and its related taxa. Sci. Rep. Tohoku Univ., 4th ser., Biology Vol. 38:81-156.

The Origins of the Genus *Byblis*

By John D. DeGreef (6, rue Libotte B-4020 LIEGE BELGIUM)

There are two species of *Byblis*, *B. liniflora* SALISB. from the monsoonal regions along the Northern coast of Australia and from New Guinea; and *B. gigantea* LINDL. which is confined to a small range in South West Australia. The climate there is Mediterranean, with rainy winters and very dry, hot summers.

Where do these species come from? In the absence of fossils the only way to find out is to try to define their place among modern taxa. Attempts to affiliate the genus to known families have all failed. So the two species are thought to form a family of their own, the Byblidaceae. They definitely belong to the large order Rosales of older authors (ENGLER, 1930). Interestingly, they are not far from Cephalotaceae! The Rosales have now been subdivided into several independent orders. The Byblidaceae are placed in the Pittosporales (see in LANG, 1901; DIELS, 1906 & 1930; DOMIN, 1922; RAVEN & AXELROD, 1974; CARLQUIST, 1976). THORNE (1968 & 1975) has neatly distributed its ten families between three geographically segregated suborders: the Daphniphyllineae from South East Asia, the Australian Pittosporineae (with the Byblidaceae), the Brunineae from Africa (with among others the Roridulaceae!).

The whole matter now appears much more clear. The place of origin of the Pittosporales is believed to have been Africa. How then did the ancestors of the Pittosporineae reach Australia? Their migration is thought to have taken place during the mid-Cretaceous (90 MYA), before the formation of the Indian Ocean. Madagascar and India were still attached to Australia and Antarctica at the time (RAVEN & AXELROD, pp. S82 & 616; Byblidaceae are not specifically named, but can be considered as included among Pittosporales). Were the ancestors of this order really such great travellers? Fossil evidence seems to offer a confirmation, at least if one accepts the identification of two pollen finds from the U.S.A., dated 100-90 MYA, as Myrothamnaceae (now an African family) (MULLER, p. 18).

What were *Byblis*' ancestors like? The splitting up of the order is so ancient, and its families (especially the ones from Australia) have evolved independently for such a long time, that the present shape does not tell us much. Yet the habitat of these plants is described as "relatively mesic". The Asian Daphniphyllineae live in moist forests. The African Brunineae grow in "moist habitats in otherwise xeric areas" (THORNE, 1975). So the ancestors of all these may have been subtropical swamp plants. The modern *Byblis* still possess the same character. This may be because they have been carnivorophytes for a long time, and wet biotopes are the only ones where such plants have a clear cut advantage over their competitors. In the meantime the other Pittosporineae adapted to the climate which became drier and drier as Australia drifted into the arid subtropical zone. They mixed with xerophytes which had been existing before in the drier parts of the continent, and whose range increased at the expense of once well-watered lands (CARLQUIST, 1976).

In a sense *Byblis liniflora* is to be considered the typical species, a plant of wet localities. *B. gigantea* is an interesting case. The plants growing alongside it are adapted to a dry biotope, as is best seen in their wood anatomy, e.g. simple perforation plates between successive vessel elements. This is true even in the other Pittosporineae (THORNE, 1975), and in *Cephalotus* (CARLQUIST, 1981). *B. gigantea* has kept its swamp xylem, with scalariform (ladder-like) end-plate perforations (CARLQUIST, 1976). I wonder whether this is also true for specimens from the drier biotopes 225 km N. of Perth (DE BUHR, 1975)? One could then consider this species as a specialized descendant of the northern swamp type. It would not have been a member of the archaic flora of West Australia, but a newcomer which has become established there.

The chromosome numbers do not contradict this: $2n=32$ for *B. liniflora* (PENG & KENTON), $2n=18$ for *B. gigantea* (KRESS). although the latter has the larger plants! This must be an example of more advanced chromosome fusion in the most specialized species, as often seen in the genus *Drosera*.

Recent fluctuations of *B. liniflora*'s range are still noticeable. During the Pleistocene glaciations sea levels were very much lower than at present. *B. liniflora* must have been growing on what is now the sea bed between Australia and New Guinea, which explains the extension of its range to this island (VAN STEENIS, 1968). Due to low temperatures and reduced evaporation many lakes and swamps laid scattered across Australia. As a result *B. liniflora* is still found far inland around waterholes.

The evolution of the Byblidaceae towards carnivory is not nearly as hard to picture as for most other genera. The Adaptations are really quite simple here: sticky hairs to catch the prey, sessile trichome-glands to digest and absorb, long thin leaves making the plant work like a spiderweb.

Sticky secretions are a common feature in the Pittosporales. Many Pittosporaceae possess resin channels near their vascular bundles (PAX, pp. 106-107). The Bruniaceae's narrow or scale-like leaves often exhibit a glandular apex (NIEDENZU & HARMS, p.289). In Australia some Tremandraceae (*Platytheca* sp., *Tetratheca glandulosa*...) have round-headed glandular trichomes (CHODAT, p.321). And last but not least, there is the interesting case of the Roridulaceae. These look very *Drosera*-like, but their tentacles produce resin, not mucus. Captures are not digested and decomposition products are not resorbed (LLOYD, 1934). All these features must be defence mechanisms against arthropods. The *Byblis* glands clearly derive from these.

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Cephalotus Follicularis: History and Evolution

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Taxonomical data

Cephalotus follicularis LABILL. is a taxonomically somewhat isolated species from S.W. Australia. Its closest relatives seem to be the Crassulaceae, a cosmopolitan family centered in Africa, and the Saxifragaceae, another widespread group originally from the North Pacific coasts (ENGLER). These taxa are now placed, together with the Cephalotaceae, in the Order Saxifragales (interesting data in SCHWEIGER, pp. 531-537; JAY & LEBRETON, p. 610; RAVEN & AXELROD, p. 586; JOHNSON, p. 38; CARLQUIST, 1981 p. 178).

The oldest fossils from the order Saxifragales date from the Upper Eocene (40 MYA) (MULLER, p. 52). Yet, for phytogeographical reasons, *Cephalotus*' ancestors are believed to have followed a tropical or subtropical migration route from Africa over Madagascar and India to Australia. In those days, during the Mid-Cretaceous (around 100-90 MYA) (RAVEN & AXELROD, p. 616) the Indian Ocean had not yet formed and the Dinosaurs still ruled the earth. Many other taxa used the same route. Later migrations (e.g. the ancestors of Australian *Drosera*) took the temperate route via Antarctica, which remained open until the Eocene.

The "normal" leaves:

A few species in the Crassulaceae and Saxifragaceae have leaves resembling the "ordinary unaltered leaves" (GILBERT, p. 159; HAMILTON, p. 381) of *Cephalotus follicularis*, most strikingly *Saxifraga dungbooi*. Could this leaf type indeed be the precursor of the modern pitchers?

On closer examination, the foliage leaves do not appear to be so normal. In a classical two-sided (bifacial) leaf, a transverse section of the petiole shows the vascular bundles usually forming an arc, with the xylem situated adaxially. The same orientation is preserved in the nerves of the leaf/blade. But in the winter leaves of *Cephalotus* the bundles form a *ring*, and their xylem faces towards the axis of the petiole. Their position is but little modified in the lamina (MAURY, p. 165; MACFARLANE, 1911 p. 7; TROLL, 1932a p. 269 + pl. 80; ARBER, p. 569 + fig. 3; LLOYD, p. 82 + pl. 10-4). This circular arrangement of vascular tissues is typical of peltate or pitcher (epiascidiate) leaves, i.e. of laminae whose adaxial surface has become the inside of the pitcher, the abaxial surface forming the exterior (TROLL, 1932a with important modifications by ROTH, 1949 & 1952). The so-called normal leaves thus appear to possess a mixture of archaic characters (a bifacial lamina) and of more advanced ones ("unifacial" disposition of vascular bundles). They must therefore be inhomogenous, teratological structures (resulting from abnormal development).

Teratological leaves:

This is the more interesting since *Cephalotus* is known to produce teratological leaves quite easily, both in culture (MASTERS, p. 314; DICKSON, 1887; HAMILTON, p. 38; SCHWEIGER, p. 498; TROLL, 1932a p. 268; HENNERN; KUSAKABE) and in the wild (HAMILTON, p. 38). These are intermediate in shape between the winter leaves and normal pitchers, and appear as inhomogeneous as the former. Some of them form almost complete pitchers, but the lid structure resembles that of the flat leaves, and what should have become the peristome is a ciliate rim. Others are flattened with almost no cavity, but the rim is rather well developed and looks like that of a normal lid. None of these mixtures of archaic and modern elements could actually represent the ancient trap.

The embryology of the *Cephalotus* leaves and traps has not yet been studied. A comparison with that of other peltate leaves (TKOLL, 1932a; ROTH, 1949 & 1952) leads to the following hypothetical model: the squat leaf initial (EICHLER, p. 194 & fig. 1) is bifacial. A ventral meristem forms on the flat adaxial face of the petiole. Cell proliferation causes the petiole to become cylindrical, i.e. round in transverse section instead of crescent-shaped as it was before. The older parts of the petiole contained a (bifacial) arc of vascular bundles. New ones form in the ventral tissues. They close the arc, which becomes a complete circle of bundles. Normally the distal part of the meristem produces a transverse ridge which will become the pitcher lid. Probably due to unfavourable conditions, this only happens to a variable extent in teratological leaves. The flat ones appear to possess no transverse parts at all. Yet I wonder if the ventral meristem does not produce at least some of the cells of the adaxial side of these leaves: firstly, the vascular bundles of the lamina keep their unifacial arrangement; secondly, the regressive leaves observed by Holger HENNERN (1987) could be considered as flat leaves with apical peltation. The distal cells of the ventral face, who decided to produce a transverse rim when the leaves were nearly finished, must have been derived from the ventral meristem also! Thirdly, the two faces of the flat leaves are histologically very similar (MACFARLANE, 1911 p. 7), i.e. of the same type as the exterior of the pitchers. TROLL (1932a p. 270) considered regressive leaves resembling the flat ones as an hypertrophy of the broadened upper part of the petiole (see sagittal section in MACFARLANE, 1911 p. 8 fig. 3A). As they are much smaller than normal pitchers, this part of the leaf is relatively much more prominent (see cover photograph of LECOUFLE, 1989!).

Were early leaves peltate?

As we just saw, the common belief that the pitchers of *Cephalotus* evolved from flat leaves, such as the ones produced at the end of the winter, must be wrong. Then what did the archaic peltate leaf look like? This foliar shape exists in several species of the Crassulaceae (e.g. *Umbilicus Pendulinus* DC) (BERGER, p. 358) and of the Saxifragaceae (*Boykimia tellimoides* ENGL., *Chrysosplenium peltata* TURCZ., *Peltiphyllum peltatum* ENCL., the genus *Rodgersia* e.a.) (TROLL, 1932a p. 237). Kidney-shaped leaves frequently occur in the Saxifragaceae. They could easily have led to peltate forms. Related species in the same family show an easy evolution from entire to incised or divided leaves, and back (ENGLER, p.9).

Now the most common teratological pitchers in *Cephalotus* possess a strange lid with two pointed lobes which are remarkably leaf-like. Rarely, there is a smaller third lobe, which is attached on the midline, somewhere on the underside of the lid (DICKSON, 1887 p.174 & fig. 4). There would have been an easy embryological explanation for the presence of two lobes: the ventral meristem is often more developed laterally than on the midline! There is no similar hypothesis I can see for the presence of three lobes.

At the end of last century, the lid of the *Nepenthes* pitcher was thought to derive from the fusion of archaic folioles (secondary leaflets). This theory has been abandoned in the absence of confirmation from embryology or from the geometry of the lid's vascular system (see in LLOYD, p.60). But things lie differently here. The vascular supply of the *Cephalotus* lid has been shown to lack a median nerve. Each half of the operculum receives its own bundles (ARBER, p.569). From this and from the teratological data mentioned above, one may infer that the lid derives from the fusion of three leaflets, or of three lobes, depending upon whether the peltate leaf was only incised, or truly divided. The tissues and vascular supply of the insignificant median foliole cannot be traced in the modern operculum and in most regressive leaves. Yet the lid receives three main bundles (MAURY, p.164), with some variability due to anastomoses (ARBER, fig. 4,B & C1-2). There is also the occasional bundle crossing the midline, which in a way is a violation of the lid's bilateral symmetry.

Was the ancient leaf truly divided? The fact that the three-lobed regressive lids are not really trifid, but that their median lobe possesses its own attachment, seems to indicate that it was. In teratological leaves the lid is often as large as the pitcher. The ancestral leaf may therefore have been constituted of three about equally sized folioles, plus a smaller one.

What could have caused the evolution towards carnivory of ancestral plants with such leaves? The most archaic, and probably the least modified parts of the modern *Cephalotus* plant, i.e. the rhizome, underground scale leaves and the petioles are all covered with long hairs: but between these, numerous nectar glands can also be seen (DICKSON, 1881). Besides showing that the stem has not always been buried (why are glands there?), this confronts us with a paradox: why this mix of insect-repellent hairs and insect-attractive glands? Did the latter entice the insects to entangle themselves in the dense fur, to die there so that their decomposition products could be resorbed? But why then is carnivory not more frequent among hairy plants? There must be other factors in relation with the architecture of the leaf.

Folded unifacial leaves:

TROLL (1932b) has described a phenomenon called 'diplophyly'. Picture a kidney- or arrowhead-shaped leaf. Imagine the parts of the lamina on both sides of the petiole to curl up towards the leaf apex. Now flatten this leaf and imagine a certain degree of fusion in the area where the lateral parts are folded. You have obtained a diplophyllous leaf, i.e. one with two large flaps growing out of the lamina. Now fold this leaf along the midrib in the manner of a *Dionaea* trap, and you get the shape of *Caltha dionaeaeifolia* (Ranunculaceae) (TROLL, 1932b p.193). This plant from Tierra del Fuego was once thought to be carnivorous (see *ibidem*, p.389). It is taxonomically rather close to *Cephalotus* (SCHWEIGER, p.534), so we are not comparing totally unrelated taxa here! The surfaces of the lamina, visible from the outside, are devoid of stomata. These are the more prominent on the adaxial surface of the leaf blade and on the side of the flaps which faces towards the same. Why plants should develop such leaves is still somewhat of a mystery. Could this be a protection against the dessicating wind? Tierra del Fuego is a very rainy region, and sailors of old dreaded the storms along its coasts. Another species with such leaves, *Alchemilla diplophylla* (Rosaceae, again close relatives of Cephalotaceae!) grows half submerged (*ibidem*, p.406). I wonder whether diplophyly could be an adaptation against the rain (or the current) bleaching minerals out of the leaves? *Caltha dionaeaeifolia* grows on sterile peaty substrate with carnivorous plants. It probably could not afford to loose minerals to raindrops swept on and off its leaves.

Now what do we know about *Cephalotus*' (sub)tropical ancestors? The modern plants never form root hairs. These are reduced to minute pimples, visible under the

microscope in juvenile roots (MACFARLANE. 1911 p.2). The leaves' epidermal cells have wavy cell walls (HAMILTON, p.44). In the Saxifragaceae this is typical of species living in wet habitats (ENGLER. pp.9-10). So *Cephalotus* must always have been a swamp plant. Then why the hairs? Their localization (petioles, margins and over the abaxial nerves) could mean that they evolved to bar access to the underside of the leaves. In the tropics, this is where insects usually dwell. out of sight of predators and sheltered from the rain. Were the hairs an adaptation to the dry season? *Cephalotus'* wood anatomy shows something similar: the simple perforation plates of the xylem vessels (CARLQUIST, 1981) is typical of xerophytes, and also found in most West Australian plants (CARLQUIST, 1976). But although I have not been able to check all species, the plants growing alongside *Cephalotus* do not appear to be so hairy. Or have the trichomes something to do with windswept environments such as drafty coastal swamps? A modified peltate structure resembling diplophyllous leaves would be as advantageous during the rainy season as it is to *Caltha dionaeaeifolia* in South America all year around.

This hypothesis appears to be very fertile. One may imagine the three folioles now forming the lid as laying very close to, and indeed almost covering the apical leaflet (which has become the pitcher cavity). The adaxial surface at the base of all these could have undergone a certain degree of fusion. This would explain the ease with which the cavity of teratological structures, most prominently the winter leaves. can become obliterated.

Adaptation towards carnivory: hairs.

The evolution towards carnivory of such leaves becomes much easier to picture, too.

The idea that insects may find shelter between the leaf-lobes of *Caltha dionaeaeifolia* is an old one (HUTH. 1891). In this case nothing would prevent them from leaving afterwards. Things could have been different in the archaic *Cephalotus* leaves. To start with, ciliated rims are a frequent feature in the Crassulaceae (BERGER, p.359). That the rim of the ancient *Cephalotus* trap was ciliated is shown by the edges of the lid and pitcher of many regressive Leaves. In the original, flattened peltate trap the entrance would have been a arrow horizontal slit between the more or less fused lid folioles and the "pitcher" leaflet. Ciliae on both rims would have been effective in preventing egress if they were directed towards the inside. Their number would then increase and they would invade the pitcher inside, until they made up a broad band along all margins. As the apical leaflet transformed more and more into a pitcher, the trichome-covered walls tended to become vertical. So did the lid, and the opening of the trap became too wide to be closed off by cilia. The unicellular hairs then became shorter and shorter until they were reduced to the scaly cell processes now covering the underside of the lid, the peristome and the slippery funnel underneath.

A tight row of very short hairs is still found on the rim of the modern lid. Its aim probably is to seal the maturing pitchers, which are tightly closed. Since there are no transition forms between these short hairs and the scales in the inside of the lid (as I have ascertained), their homology with the latter remains dubious.

Translucent patches:

These trichomes are very prominent on the lid of the juvenile type of pitchers, together with the well-known array of translucent areolae. The usefulness of these has been much debated. Since the operculum of mature pitchers is almost vertical (when the pitcher rests obliquely against the ground), the clear patches do not appear to be of much use. In pitchers of young rosettes the lid remains fairly horizontal. The windows serve a greater purpose there and appear relatively larger. In the archaic leaf

with its narrow entrance the areolae must have been even more useful. They may now be vestigial structures.

The peristome :

One of Holger HENNERN's (1987) teratological leaves shows that in the past all the margins, including what is now the peristome, were of the same type, i.e. with alternating translucent areolae and coloured ridges. This confirms ARBER's 1941 hypothesis which said the ring-like structures of the modern peristome are homologous with the thickened ribs of the lid. The second HENNERN leaf may show how the normal peristome developed: by a process of folding in the manner of a mediaeval purse. The thin translucent parts became obliterated. Such a thickening of the leaf margin is no exception in the Saxifragaceae where undulated, knobby or toothed rims have been described. The marginal thickening does not entirely spare the *Cephalotus* lid. Its edge is clearly bloated where it meets the peristome. This can be very prominent in regressive leaves (see LLOYD, pl. 10-18), but scarcely sufficient to indicate that the lid results from the fusion of five instead of three folioles!

The flanges:

Two pairs of well defined creases on the exterior of the pitcher (one on each side of the median flange) may also be remnants of this folding process. They probably contribute to the strength of the pitcher wall, a role also attributed to the ciliated flanges which are prominent features of this plant. These must be of considerable antiquity, as they are seldom lacking even on the most primitive regressive leaves. They are always situated over major vascular bundles, and must be homologous with the thickened nerves seen on the abaxial leafside in many taxa. The *Cephalotus* pitcher rests obliquely against the ground. It would tend to sag, forming a horizontal crease on its foreside, if it were not for the crests. The prominent ciliation shows these to be insect guides (not paths!). Their hairs also provide protection during the growth of the pitcher buds. The two faint ciliated ridges between the lid margins and the petiole have sometimes been considered as the rims of the adaxial side of the leaf (ARBER, p.569). Since this latter is unifacial, this cannot be true. These ridges could mark the site of fusion between the ciliated margins of folioles. They could also be folds of the basal, undivided part of the peltate leaf. The other lines of fusion between lid leaflets have vanished. Why then has this one been preserved? Maybe because its ciliae are useful in turning insects away from the lid where they would escape capture?

The origin of the glands:

But all these structures would be useless without alluring and digestive glands. The presence of glands on all surfaces of the modern plant (and not only on the ones involved in carnivory) shows that they must derive from widespread elements. Possible candidates are: stomata, water-stomata, normal or glandular hairs. The small trichomes of the lid margin appear able to absorb safranin (HAMILTON, p.39). This seems insufficient to establish a relation with the glands. Unaltered stomata still exist on all external surfaces alongside the glands (DICKSON, 1881; MACFARLANE, 1911). Water-stomata are known in some Crassulaceae (BERGER, p.367) and in at least six genera of the family Saxifragaceae. Many of the latter's species live in humid or wet biotopes. The hydathodes do not only excrete water, but instances are known where the solution contains so much calcium salts that they accumulate on the leaves (ENGLER, pp.11 & 29). Hydathodes appear to be the best candidates in an ancient swamp dweller such as *Cephalotus*.

Some glands of the digestive patches of the pitcher inside look a lot like stomata (DICKSON, 1881), and these have now been shown to secrete enzymes (JUNIPER, ROBINS & JOEL, p.177).

The smallest glands of the peristome possess two surface cells which sometimes resemble stomata with a vestigial pore (SCHWEIGER, p.508 & figures 25-26; compare with PARKES & HALLAM, fig. 1-4 and JUNIPER et al., fig. 6.35).

The larger, fluid-producing glands of the pitcher cavity derive from these, even if they do not look like stomata. Connections of the largest among them, and of the peristome nectaries, with dead-end tracheids of the vascular system have sometimes been described (MAURY, p.166; HAMILTON, p.43; SCHWEIGER, p.509; PARKES & HALLAM, p.599; PARKES, 1980). This could be expected from modified hydathodes.

There are strange stalked glands in the flowers of *Cephalotus*. They also look remarkably stomata-like, but their stalk does not contain tracheids (DICKSON, 1881; MACFARLANE, 1893 p.445; SCHWEIGER, p.526). What these and the glands on the stem and petioles secrete is not known. I have checked HAMILTON's observation (p.50) that the latter indeed produce fluid which like the other secretions in *Cephalotus* does not seem to contain glucose. Gland cells are said to only give a faint histochemical reaction for glucose (EICHLER, p.497), maybe a cross reaction with another sugar?

How could the absorptive function, a prerequisite for carnivory, have appeared in such glands? According to MAURY (p.166), water-stomata are also able to absorb. They may have started by taking back salts bleached out of the plant by the rain, especially in the folded leaves, where the water could not run away quickly. To this would be added the minerals leaking out of dead insects, caught by the long hairs, maybe even before the special leaf shape was developed? The (simultaneous?) excretion of water and resorption of solutes by the same structure(s) is still obvious in the modern pitcher!

Recent acquisitions:

Four recent features have completed the trap evolution as pictured here.

The peristome has produced a series of claw-like emergences. Small insects sipping nectar from the large nectar glands situated on these will fall straight into the pitcher fluid if they lose their grip (MACFARLANE, 1911 p.9; ADAMS & SMITH, p.271).

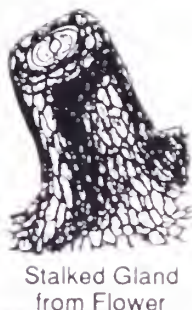
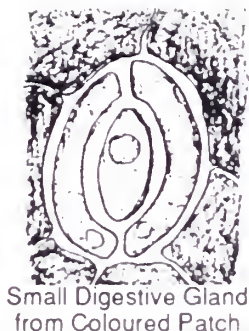
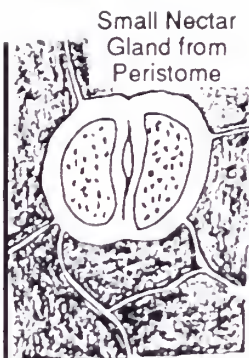
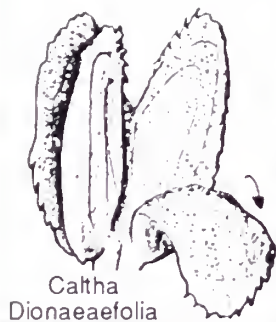
The slippery funnel has thickened and its lower rim forms an unscalable cornice. This structure appears rather late during the development of the leaf bud (HAMILTON, p.48) and must therefore be a recent acquisition.

The lid has become almost vertical and now presents some very prominent colour markings towards the outside. This may indicate that the plant is now also trying to attract flying preys, besides its usual victims, ants. In my terrarium almost all pitchers contain the dismembered remains of numerous small mosquito-like insects (and, fortunately for me, no ants).

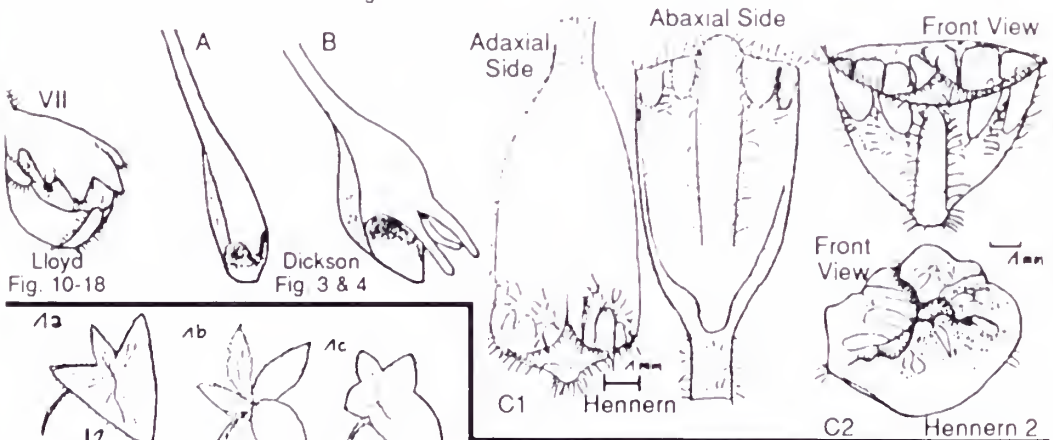
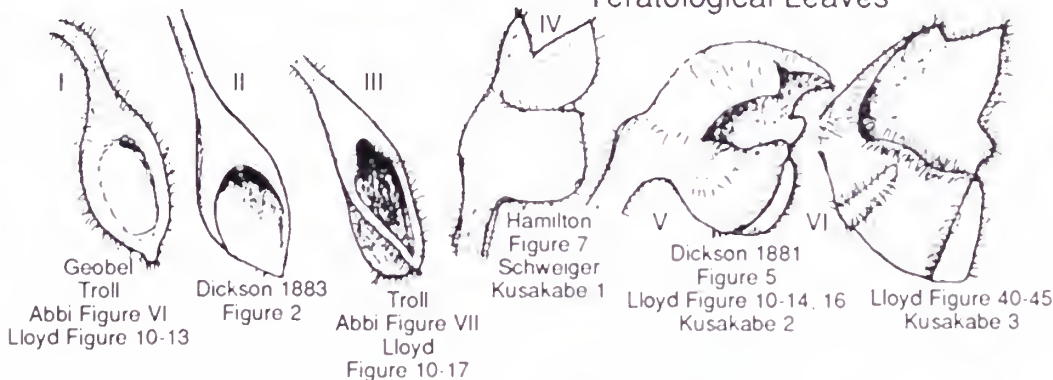
Because of the large pitcher cavity, a greater volume of secretions is needed. This is provided by giant glands sunken in two thickened patches of wall. They are not yet noticeable in 2.5 mm buds (HAMILTON, p.45), so the same conclusion applies here as for the funnel.

Acknowledgments

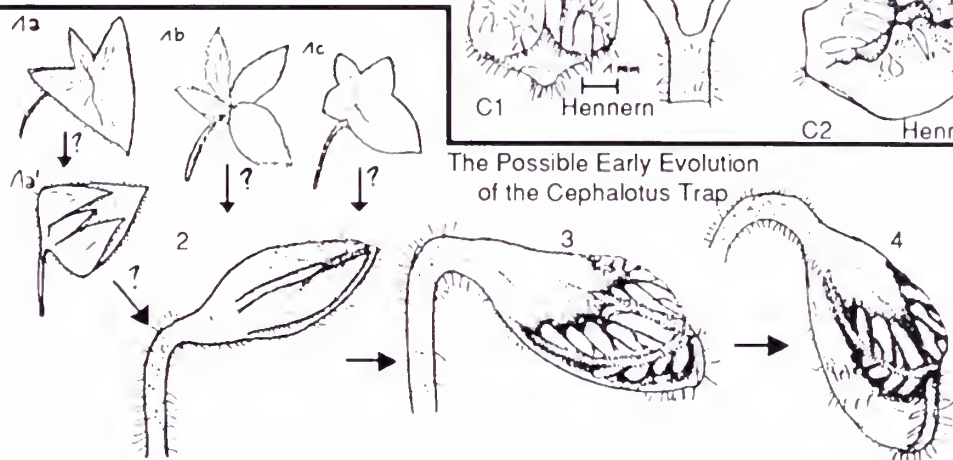
I wish to thank Holger HENNERN, who sent me two teratological leaves of an as yet undescribed type, and also Mr. Isamu KUSAKABE, who let me use his excellent photographs of regressive leaves.



Teratological Leaves



The Possible Early Evolution of the Cephalotus Trap



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Grafting of *Nepenthes*

By Cliff Dodd (2225 S. Atlantic Ave, Daytona Beach, FL 32118)

During the last few years, many *Nepenthes* species have come into cultivation worldwide, some for the first time, even as their home ranges shrink under human development. As with any multi-species genus, there are species relatively easy to cultivate and those more elusive. The problems with difficult species can be as numerous as the plants themselves: temperature cycles, moisture levels, and one of the least understood parameters, simulating native soils or providing an appropriate alternative.

Transplanting species narrowly restricted to certain soils into an artificial media frequently results in poor growth, chlorosis (yellowing of the leaves), and eventual death. When such plants are removed from the media, few or no live. Roots are found or the root system is often extremely poor. Growth from seed in these mixes is also difficult with seedlings frequently never growing beyond the cotyledon stage.

If the native soils cannot be duplicated and roots will not survive in exotic media, grafting may be a reasonable alternative. Known from Biblical times, grafting was (and is) used to perpetuate a particularly fine species or cultivar, or to cope with nutritional, disease or pathogenic problems in a soil exotic, or even hostile, to the desired plant. The idea of grafting *Nepenthes* is not new and has been tried locally on several occasions. Most involved using an already established rootstock, and attempting to graft on a scion of the desired species. Invariably the host rejected this material, the reason not being entirely clear. This method should not be entirely rejected and is worthy of experimentation. As an alternate method, both rootstock and scion were taken as cuttings to form a whip graft. The rootstock consisted of two node lateral cuttings in which the dormant eyes were removed. The scion also consisted of a lateral cutting as opposed to a tip, the latter being more prone to rot under mist.

Ideally, the stem diameter of both scion and stock should be similar. A razor blade is used to shape the stems in the manner shown. (Figure 1) and after matching the cuttings the joint is wrapped tightly with plastic grafting tape. Not being self-adhesive

the loose ends are simply tied in a knot. The cuttings are then inserted into the hole made in the bottom of the inverted styrofoam cup and placed under mist.

Common material was used as a first experiment. Plants cut for rootstock are either hybrids or species known for vigor. Size of material to be grafted was matched to rootstock. In this case *N. rafflesiana* onto *N. x mixta*, and *alata*, *fusca*, and *reinwardtiana* onto *N. alata* common green form. Both scion and rootstock of the above plants are more or less easily cultivated and were used to see if grafting was even feasible in *Nepenthes*.

Cuttings were left on the mist bench until roots were visible under the cup and the dormant eye of the scion began to break, at which point they were potted in a standard mix. After the plants were removed from the mist bench, the tape was left on for roughly four months. When removed, an area of tissue fusion could readily be seen where the graft met. (Photo 2). One problem in the successful graft occurred when the tape was removed. The fused tissue under the tape was used to 100% humidity and nearly pulled apart in the first 24 hours when exposed to ambient air. It would be advisable to replace newly unwrapped cuttings under fine mist for a few days and gradually harden them off to reduce this possibility. Plants must also be staked or supported in several places along the stem to avoid pressure on the graft area.

The results of the first series of grafts was mixed and only 25% successful. This was *N. rafflesiana* on *N. x mixta* rootstock. The amount of roots produced by *N. x mixta* was amazing and showed the effect of hybrid vigor. Growth of this graft has been steady and the plant has produced two upper pitchers of *N. rafflesiana* eight months after being placed under mist on Nov. 1989 (Photo 3).

The other three plants did not succeed for different reasons. Oddly, *alata* on *alata* using the same clone as a control plant did not show tissue fusion and the cutting eventually rotted under mist. The second, *reinwardtiana* on *alata* rooted well and showed some evidence of growth but the scion subsequently became infected with scale insects and died. The rootstock eventually broke another node and is still alive. This in itself is interesting in that the obvious two nodes of the stock were initially destroyed. The third, *fusca* on *alata* was the most frustrating since the graft showed tissue fusion and the scion was showing growth and indeed was starting to flower, when the *alata* rootstock aborted its roots and died.

It should be noted that this is not intended as a cure-all for *Nepenthes* propagation. It is unlikely that *N. rajah* grafted unto *N. x mixta* or *N. dyeriana* would survive all the rigors that these hybrids will tolerate. It is also unclear whether lowland rootstocks would suit highland temperature conditions and in the case *N. fusca* or *N. spathulata* might serve well due to their vigor. It is at least possible that plants whose native soils cannot be duplicated may benefit from this technique. There is still the obvious problem of obtaining the material for grafting. Species that have proven difficult to cultivate are seldom available for experimentation. It is less clear whether the scion will eventually produce basal shoots although this should be possible. All similar shoots on the rootstock should be destroyed to prevent the plant from putting all of its energy toward the stock and aborting the scion. Visions of several exotic species on one rootstock are unlikely, but might be possible.

For the idea to try grafting for its possible benefits, I wish to thank Peter Able of Sydney Botanic Gardens, Australia. Working with species of *Grevillea* endemic to ultra basic soils of New Caledonia and nearly impossible to cultivate elsewhere, he tried grafting onto the easily cultivated native Australian *G. robusta* and the plants not only thrived but grew large, flowered and are now offered as landscape material.

I would encourage more experimentation with *Nepenthes*. It is unknown whether they are more or less difficult than other plant species to graft but of several different genera of plants and shrubs I personally have tried, this was the only success. Think what someone skilled in this area could do! How about it CPers?

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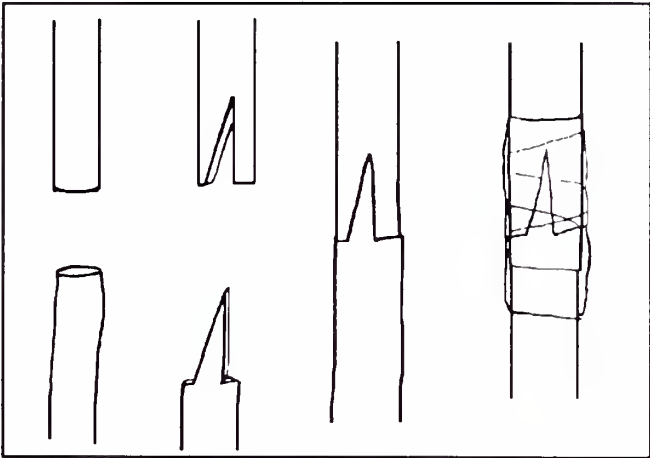


Figure 1. Scion and rootstock showing interlocking cut ends to be joined and wrapped with grafting tape.



Photo 1. Closeup of area of tissue fusion



Photo 2. Overall view of grafted *N. rafflesiana* on *N. x mixta*

Nepenthes Veitchii

By Cliff Dodd (2225 S. Atlantic Avenue, Daytona Beach, FL 32118)

Nepenthes veitchii Hook, f. occurs in the northwest to north central area of the island of Borneo, including Sarawak and western Sabah and in Malaysia and northern Kalimantan, Indonesia.

It was first described in 1858, and in Danser's now classic monograph it is placed within the *Reoia*e, a more or less natural group within the genus containing some of the largest and most spectacular species.

Two distinct forms of the plant are known: One from lowland areas near sea level in western Sabah, and the other confined to moderate altitude mossy-forests to around 5000 foot elevation in northern Kalimantan. Intermediates of the two may exist but at present are not positively identified. The main differences are listed below:

Lowland

leaves: lanceolate, gradually originating stem, leaf margins in one plane.
petiole: indistinct.
peristome: generally green, blushing pinkish or brown with age.
Trichomes: very fine or absent.

Highland

oblong, abruptly originating from stem, leaf margins ruffled.
distinct.
green or striped, blush-pink or reddish with age.
all plant parts covered with coarse hair to nearly .25 inch in length.

Locally common in some areas of its range, the species is frequently overlooked due to its habit of growth. In the habitat, the plant occurs as either epiphyte or terrestrial. The lowland form prefers areas of high humidity and may be found in diptocarp trees overhanging rivers, or rooted terrestrially in iron ore derived soils and on white sand soils (highland form) with the stems climbing nearby trees. Plants are also found on ultrabasic derived clay, decomposed granitic and sandstone derived soils. One plant was seen covering a tree stump of a logged tree, (B. Sutton, personal communication, July 15, 1990).

The growth habit is unusual and well designed for an epiphytic existence. Seeds are wind distributed, and upon settling on a proper habitat such as a mossy fork of a tree, seedling plants develop into a rosette of leaves typical of juvenile *Nepenthes*. However, as the plant matures the leaves begin to take on a 180 degree orientation and to creep along branches. This orientation distributes the weight of the pitchers on either side of the branch giving such a heavy plant greater stability. More unusual is the habit of some plants to climb straight up a tree trunk, clasping the trunk with their alternating leaves as they ascend.

Cultivation

Cultivation of the lowland form of *N. veitchii* is relatively easy. The plant is very adaptable to a wide range of conditions. However, the following culture method has been quite successful over at least a five year period. The highland form is more difficult and differences in its culture are noted where applicable.

Container: Does well in most open containers. Slatted orchid baskets made of cedar or galvanized metal. (lined with plastic mesh to hold media) work well. The lowland form does well in a plastic pot although care should be taken to insure drainage and aeration of the media.

Media: Must be open and well drained. Equal parts fine fir bark, charcoal, and

treefern are a good basic mix, roughly equivalent to media for moisture loving epiphytic orchids. It should not dry completely between waterings.

Water: up to 140 ppm has not proven to be harmful if media is well flushed; however, plants do far better with pure water and media will last much longer.

Temperature: from 45 degrees F. (for short periods only) to 100 degrees F. in the lowland form, more critical if some fluctuation. 82 degrees F. maximum for the highland form with night temperatures in the mid 50s. This day-night, warm-cool temperature cycle is critical in highland montain *Nepenthes* and should be a constant parameter for successful cultivation.

Lighting: Bright filtered light for the lowland form, somewhat more shade for the highland form, especially in hot sunny weather.

Humidity: High, but with good air circulation.

Growth: This is the greatest drawback of the species. *N. veitchii* grows at roughly half the rate of most species. Seed may take six to eight months to germinate (C. Powell, personal communication, July 1990). A seedling may take up to five yars to begin to produce adult pitchers and long to fully nature and flower. The pitchers of the immature plants are not spectacular and resemble those of *N. mirabilis*. The plant is compact for a *Nepenthes* with short internodes and is manageable in a relatively small space for long periods.

Flowering: In cultivated plants this occurs mid summer. Male plants may produce two or more racemes in succession per growth head, females usually one. Seed development takes approximately 2-3 months with 500-1000 seeds per raceme. The species hybridizes well but does not seem to be dominant in the offspring.

N. veitchii is well worth cultivating. Its unusual growth habit and huge peristomes make it a standout. Sadly, in the wild as an epiphyte, it may one day go the way of the trees it makes its home.

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Highland form of *N. veitchii* with striped peristome



A Cuban Treefrog
Osteopilus septentrionalis
peers from a pitcher of *Nepenthes veitchii*
where it sojourns during daylight hours.



Lowland form of *Nepenthes veitchii*
with immature male inflorescences



Close up of pitcher of highland form

The Conservation Of Carnivorous Plants

By Martin Creek

The author—secretary of the IUCN/SSC Carnivorous Plant Specialist Group discusses the conservation challenges that face the species of Carnivorous Plant.

Since the 1970s, a great revival in public interest in Carnivorous plants as curiosities for the windowsill and greenhouse, not seen since the end of the last century, has been fueled by a steady supply of plants, particularly the venus fly trap and the American pitcher plants. In Western Europe, these have been marketed through garden centres and supermarket chains, largely in inadequately small pots, unsuitable compost, with misleading growing instructions. It seems very likely that these plants were originally wild-collected, the Netherlands merely serving as a transshipment station.

The pitcher plants, for example, are often imported into Europe as aged plants with immense, often pest-infested rhizomes of many years growth: one would expect cultivated plants to be younger, cleaner and more uniform in size. Lately, the plants offered for sale have improved in health and quality, but the suspicion is still that many may be of wild origin. Since such plants as the venus fly trap, for example, occur only in a restricted habitat and only in the U.S. Carolinas, the fact that tens or hundreds of thousands of plants are offered for sale every year in Europe alone, with little evidence of artificial propagation on any scale, must be a cause for concern to those interested in the long-term survival of this species in the wild. More information on the extent of plant collection and the effect this has on wild populations is imperative.

Of even more concern are some of the rarer American Pitcher plants such as *Sarracenia oreophila* (see photo), promoted as one of the world's 12 most endangered animal and plant species in 1988 by IUCN (Species 10:22-24). This species is now known from less than a dozen sites in N.E. Alabama,¹ endangered, not only by habitat destruction, but also, it is believed, by collection for the international trade in rare plants. Fortunately, this pitcher plant and two others, *S. rubra* ssp. *jonesii* and *S. rubra* ssp. *alabamensis*, have been listed on Appendix I of CITIES since 1981, effectively limiting their international trade. Moreover, all other species of *Sarracenia* and the California Cobra Lily *Darlingtonia* have been listed on Appendix II since 1987 and 1981 respectively—not hindering international trade, but demanding that they are accompanied by CITIES permits, so that trade can be monitored (Knees and Cheek, 1988). Regrettably, it seems that some traders successfully ignore the permit requirement when shipping plants.

The Australian pitcher plant, *Cephalotus follicularis*, which is accorded its own family, has been listed on Appendix II for many years. Although there is evidence of continued destruction of its highly restricted coastal swamp habitat for housing and golf course construction in Western Australia, the good news is that pressure from collectors seems to be dwindling as tissue culture techniques are increasingly efficient at producing inexpensive saleable plants to meet the demand from carnivorous plant growers.

The Asian pitcher plants, *Nepenthes*, are by far the most numerous and widespread of all pitcher plants. Unfortunately, many of the 70 or more species, often the most dramatically sculptured and beautifully coloured ones, are restricted to only a single mountain and thus highly vulnerable to extinction through excessive collection. Requiring warmer conditions than the American pitcher plants, their fate is not the supermarket and windowsill, but the tropical greenhouse of the wealthy orchid or

¹Ed. Note: Also, note recent sites in northeast Georgia and southwest North Carolina.

specialist collector. In Western Europe, some of the rarer species are listed by suppliers at 140 pounds sterling (c. U.S. \$230) each. Higher prices are probably obtainable in California and especially Japan where there appears to be a much larger demand.

In Borneo, one of the richest pitcher-plant hunting grounds, several cases of theft by commercial growers from Mt. Kinabalu, a Malaysian National Park and home of several *Nepenthes* species, have occurred in recent years. Particularly affected as been *Nepenthes rajah*, famous for its glistening red, rugby-ball sized pitchers that hold many pints of digestive fluid and trap rats. It is now believed to be restricted to only two or three populations on serpentine soils.

Two species, including *N. rajah*, are listed on Appendix I, the others all on Appendix II., but, as with *Sarracenia*, this has been effective only since 1981 and 1987 respectively, and it is still too early to say how effective this has been in monitoring and controlling trade.

The threat from trade does not seem so great amongst the sundews, rainbow plants, butterworts and bladderworts as for the pitcher plants, though several of the most spectacular and sought after species of Sundews and Butterworts are limited to only one or two populations and are thus vulnerable to extinction through collection. The larger threat in these groups seems to be through habitat destruction, as the wetlands in which they live are drained for agriculture, or planted for forestry. Many *Drosera* are restricted in distribution, *D. regia* being known only from a single mountain. Many other South African *Drosera*, for example *D. alba*, *D. acaulis*, *D. cuneifolia* (Obermeyers, 1970) and *D. slackii* (Cheek, 1987; Bennet & Cheek 1990) have highly restricted distributions and so are also vulnerable. In Western Australia, where *Drosera* are more concentrated than anywhere else on the globe, the tragedy is that until very recently (Lowrie, 1987, 1989), no competent inventory of the species has been made. Even now, more than half of the species of pygmy sundews are so recently known to science that they lack legitimate botanical names. Some of the species now exist as only single populations and several are threatened by habitat destruction—clearing for agriculture, forestry or mining. As Lowrie (1989: 70) says of one of his new species *D. leioblasta* is only known from one location, just north of Cataby. Extensive clearing has destroyed most of its former habitat. This prompts the thought that, if Lowrie has delayed his work by 10 years, even that single location might itself be destroyed by clearing and the world would forever be ignorant of this species ever having existed. Who knows how many more species of pygmy sundews Lowrie and his fellow enthusiasts might have discovered if they were born a generation ago, before clearance had proceeded in Western Australia as far as it has today?

The rainbow plants, *Byblis*, like *Cephalotus* are restricted to Australia and accorded their own family and Appendix II status. The two species differ greatly, the shrubby *B. gigantea* is restricted and vulnerable to clearance, whereas the annual *B. liniflora* extends across Northern Australia and is virtually a weed—certainly not worthy of Appendix II status.

No butterworts are known definitely to be affected by trade, but several of the poorly known Mexican species, e.g. *Pinquicula agnata*, have very small ranges (Taylor & Cheek, 1983) and might easily be wiped out by a single mining operation.

The Carnivorous Plant group is one of almost 100 specialist groups of the Species Survival Commission (SSC) which advises International Conservation bodies, particularly its parent body IUCN (International Union for Conservation of Nature and Natural Resources) on conservation matters. Specialist groups advising on animals, for example African Elephant and Rhino, and Parrots have existed for many years, and only relatively recently have groups advising on plants, for example the Cacti and Succulent group, come into being. The primary role of Specialist Groups is to speak generally for the species concerned in a conservation context and a key part of this is

to identify species that have difficulties in conservation terms. Once this has been done, the relevant international conservation bodies and authorities can be informed, where necessary pressurized and an assessment made of the possibility of removing the difficulty. At present the Carnivorous Plant Specialist group consists of a network of half a dozen volunteers scattered throughout the world in areas where a high diversity of species of Carnivorous Plants occur. However, these few cannot provide complete coverage of every carnivorous plant species. If YOU are concerned that a species is being threatened, whether by habitat destruction for agriculture, forestry, mining or housing, for example or by collection for the horticultural trade, please let me know, giving precise details and your name and address so that I can contact you. Without such information, the group cannot serve its purpose.

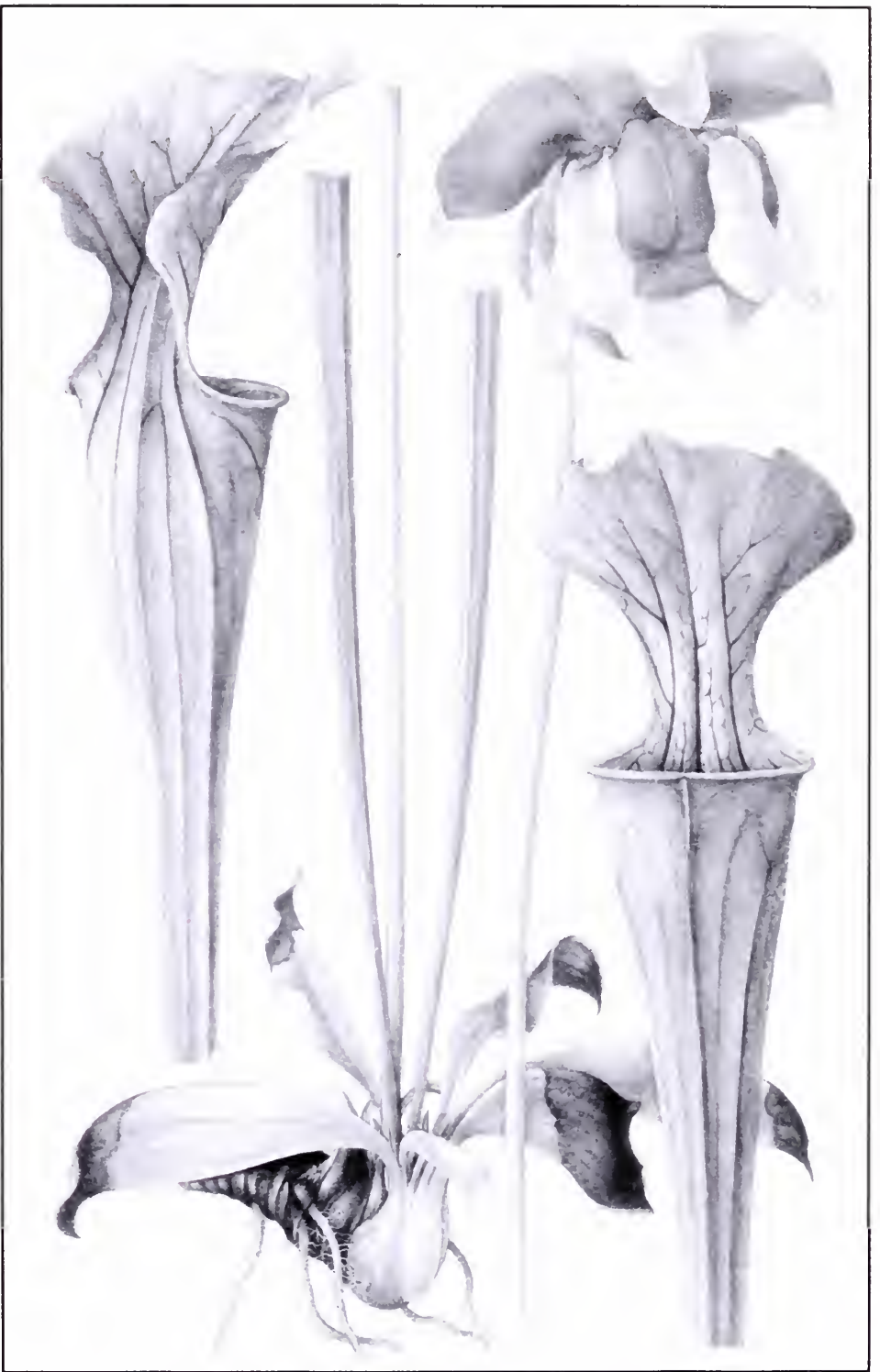
The author is grateful to Anne Mayo for her encouragement and comments on this article and to the Kew Magazine for permission to reproduce the painting of *Sarracenia oreophila* by Joanna Langhorne—to appear in colour with an article solely on this plant in a future number.

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More News and Views

Erik Holtzapple (105 Hollytree Lane; Simpsonville SC 29681 USA) writes: I'm a high school student working at Roper Mountain Science Center and I'm trying to raise funds for a place for CP to be exhibited at the horticultural building at the Roper Mountain Science Center. I would be thankful if some of our members contribute CP and/or money to this project. We have a nice greenhouse to cultivate CP. Mr. DeBoer, the head naturalist at the Science Center, wanted me to write this letter to you all since I'm a member of the ICPS. I also want CP to be open to the general public to educate them of this fascinating group of flora, especially the SE US plants, to show how close these plants are growing to them; (also the Venus' flytrap and *S. rubra jonesii*) and a wide variety from other parts of the world. I am contributing a part of my collection and I hope you will too. If you can, please write to me or to Mr. Peter DeBoer; Roper Mountain Science Center; 504 Roper Mountain Road; Greenville SC 29615-4229 or phone him at 803/297-0232.



Sarracenia oreophila

Literature Review

Brugger, J. and Futishauser, R., Architecture and development of non-aquatic species of *Utricularia*. Bot. Helv. 99(2): 91-146. 1989.

The old view that in *Utricularia* each primordium can develop into any kind of organ is only partially correct according to these authors. There are still some developmental and positional constraints but these are very relaxed and deviate from construction rules valid for most flowering plants. The parts are designated leaf, stem (stolon) and bladder but the classical criterium for distinction between stems and leaves does not apply. A leaf tip may continue its growth and develop into a stolon, or a stolon may become determinate and flat, thus forming a terminal leaf. Three terrestrial and four epiphytic species were studied.

Crouch, I.J., J.F. Finnie and J. van Staden. Studies on the isolation of plumbagin from in vitro and in vivo grown *Drosera* species. Plant Cell Tissue Organ Culture 21(1): 79-82. 1990

Drosera auriculata roots contained more than twice as much plumbagin as in vivo grown *D. capensis* plants. *Drosera natalensis* have half the amount and it was concluded that extraction of this chemical for commercial uses was not feasible.

Fromm-Trinta, E. The genus *Utricularia* L. in Brazil: V. Species of the southeastern region. Bradea 5(24): 267-274. 1989.

In the area around Sao Paulo, there are 30 species of *Utricularia*, of which 9 are aquatic, 3 epiphytic and the rest terrestrial.

_____. 1988. *Lentibulariaceae* do Brasil. II. *Utricularias* epifitas. Bradea 5:91-107.

_____. 1988. O genero *Utricularia* L. do Brasil. II. Especies da regioao norte. Bradea 5:125-135.

_____. 1989. O genero *Utricularia* L. do Brasil. III. Especies da regioao nordeste. Bradea 5:188-194.

In Portuguese. These three papers are covered together since they encompass reviews of *Utricularias* in Brazil. The first covers the epiphytic species, the second species of the north to the border of Venezuela, and the third in the northeast of her country. All papers have keys, listings of collected specimens (herbarium) and locations, comments on habitat and range, and an extensive bibliography. The first paper on the epiphytes also includes complete descriptions and line drawings of each species. (DES)

Givnish, Thomas J. 1988. Ecology and Evolution of carnivorous plants, Pp 243-290 in Abrahamson (ed.), Plant-Animal Interactions. McCraw-Hill, New York.

This chapter in a book on Plant-Animal interactions constitutes an extensive review of the literature on carnivorous plants viewed from the ecological

perspective. Among the topics which are extensively covered are: Geographic and ecological distribution, Prey specialization, Mutualism and digestive symbionts, Competition with animals for prey, Pollination, Nutritional benefits of carnivory, Autotrophy vs. heterotrophy in carnivorous plants, and Cost-benefit analysis of the carnivorous habit.

Questions such as why carnivorous plants so often occur in sunny, wet, mineral poor and burned over habitats are reviewed and discussed. Because of the incomplete state of knowledge, complete answers to these questions are not always possible but a review of the relevant work and clear suggestions for the direction future research are presented. (SEW)

Greenway, W, J. May, S. English and F.R. Whatley. Metabolism of nitrogen -15-glycine and carbon -13-glycine by *Dionaea muscipula* studied by gas chromatography-mass spectrometry. *New Phytol.* 114(4): 581-588. 1990

Traps were fed the labeled amino acid glycine and it was found that labelling was detected in glycine and serine with both labels of carbon and nitrogen. The nitrogen labelling alone was found in alanine, aspartic acid, and glutamic acid. Only the trap and lamina contained the labels.

Kondo, J. and Segawa, M. A cytotoxic study in artificial hybrids between *Drosera anglica* Huds. and its certain closely related species in series *Drosera*, section *Drosera*, subgenus *Drosera*, *Drosera*. *Kromosomo* (Tokyo) 2(51/52): 1697-1709. 1988.

Artificial hybrids between the tetraploid species *D. anglica* ($2n=40$) and the diploid species *D. capillaris*, *D. filiformis*, *D. intermedia* and *D. rotundifolia* showed intermediate chromosome numbers and complements of the bimodal karyotypes at mitotic prophase and metaphase. The same tetraploid species was crossed with *D. spathulata* ($2n=40$) "Kanto-type" and with *D. spathulata* ($2n=60$) "Kansai-type" to give hybrids that showed various configurations with various multivalent formations.

Kreher, B., Neszmelyi, A. and Wagner, H., Naphthoquinones from *Dionaea muscipula*. *Phytochemistry* (Oxf.) 29(2): 605-606. 1990.

Beside plumbagin, a new compound hydroplumbagin has been isolated from *Dionaea* which joins two known naphthoquinones, droserone and 3-chloroplumbagin for a total of four of this family of compounds from this genus.

Malayan Nature Society, 1990. Endau-Rompin—A Malaysian heritage. *Geo* 12:32-43.

This article is an abstract from a book of the same title in this Australasian Geographic magazine. It features a natural history expedition to this area of Malaysia. Regarding CP, there is an excellent full page color photo of *Nepenthes ampullaria*. The *Nepenthes* are mentioned little in the article, but the photo legend mentions that a small species of crab was found inhabiting many of the pitchers where it apparently fed on captured prey remains. (DES)

There are 30 accepted Borneo species of *Nepenthes* with 5 of them absent from East Malaysia and Brunei and these five are located in the mountains of Indonesian Borneo. There are also natural hybrids which are more common than B. H. Danser indicated in his 1928 monograph on the genus.

The authors give brief descriptions and locations for these species which in this short article is adequate but the greatest portion of the space is devoted to many color photos of species and hybrids (about 80 in all). This is followed by the Biology of the plants with facts that we know so well from other texts but there are also many interesting relationships especially between insects and a plant that preys on them! *Nepenthes* pitchers, we find, not only protect insect pupa and eggs of insects but about 150 different species of insect larvae thrive in the liquid! Spiders set traps for insects in the upper part of the pitcher and hide in the liquid when disturbed. Many ants zealously guard their pitchers while lapping up the nectar secreted by the peristome. And it is well-known now that *N. bicalcarata* plays host to a colony of ants. Finally, studies on the development of a *N. villosa* pitcher way up into the clouded Mt. Kinabalu takes 8-10 months to mature and lasting as long.

There are many uses for this plant ranging from medicinal drugs and cooking utensils to making rope.

Finally, the best descriptions are detailed for *N. veitchii* including a magnificent cover photo and for *N. northiana* and *N. edwardsiana* which are all rarely found species and little was known about them in the past. In this article, we learn more information about them as they fill their ecological niches.

Back copies of this magazine may be obtained from the publisher:
The Publisher, Tropical Press Sdn. Bhd., 29, Jalan Riong, 59100 Kuala Lumpur, Malaysia. Price is \$3.50 U.S. currency by surface mail.

Reddy, M.M., The genus *Utricularia* L., in Marathwada (India). J. Econ. Taxon. Bot. 12(1): 110-112. 1988.

Six species of this genus are described with a diagnostic key and critical notes on their distribution are presented. *U. bifida*, *U. polygaloides*, *U. caerulea*, *U. Striatala*, *U. Ulinosa*, and *U. stellaris* are noted.

Rogers, W.A. & Gupta, S. The pitcher plant (*Nepenthes khasiana* HK.F.) sanctuary of Jaintia hills, Meghalaya (India): Lessons for conservation. J. Bombay Nat. Hist. Soc. 86(1): 17-21. 1989.

This *Nepenthes* species is considered an endangered endemic plant and a pitcher plant sanctuary was set up in 1974 to protect it. The sanctuary has declined in conservation status over the past decade and the authors urge the state and conservation agencies to continue a viable level of protection.

Santos, E. The Genus *Drosera* L. in Brazil: II. On *Drosera montana* St.-Hil. *Bradea* 5(21): 249-256. 1989

The name *D. montana* was applied to many other species and varieties of *Drosera* in the past. In this study, the author tries to deal with the confusion and to revalidate the *Drosera* species of *tormentosa*, *hirtella* and *hirtella* var. *lutescens*.

Schulze, W., and E-D. Schulze. Insect capture and growth of the insectivorous *Drosera rotundifolia* L. *Oecologia* (Heidelb) 82(3): 427-429. 1990

It was observed that rates of insect capture increased with leaf area and that leaf loss equaled leaf growth in plants having a natural rate of insect capture. Nitrogen from prey was stored in the hypocotyl and it was estimated that about 30% of the nitrogen stored after winter originated from insect capture in the previous season.

Speta, Franz and Franz Fuchs, 1989. Drei neue *Pinguicula*-Arten der sektion *Orcheosanthus* DC. aus Mexico. *Phyton* 29:93-103.

In German. Three new species of *Pinguicula* are described from Mexico, these being *P. laeueana*, *P. rectifolia* and *P. potosiensis*. The first two are from the state of Oaxaca, and the third from San Luis Potosi. Latin descriptions as well as description in German are given, along with habitat and cultivation notes. There are line drawings and black and white photos as well. (DES)

Taggart, J.B., S.F. McNally and P.M. Sharp. Genetic variability and differentiation among founder populations of the pitcher plant (*Sarracenia purpurea* L.) in Ireland. *Heredity* 64(2): 177-184. 1990.

Presently, this pitcher plant grows on six sites in Ireland as a result of being transplanted initially in 1906. The authors tested the genetic variability among the populations and found that the overall level was low, but within the range recorded for native North American populations.

Tammaro, F. and Pace, L. The genus *Pinguicula* L. (Lentibulariaceae) in central Italy and description of a new species: *P. fiorii*, new species. *Inf. Bot. Ital.* 19(3): 429-436. 1987.

The damp gorges in the Majella mountain (Abruzzo, Italy) area shelters a *Pinguicula* distinct from 3 other species found in central Italy: *P. vulgaris*, *P. leptoceras* and *P. reichenbachiana*. The new species shows morphological affinity with *P. balcanica* but differ from it in the leaves and flowers. Named after the author of Flora of Italy, the chromosome number is $2n=32$.

Taylor, Jan. 1990. The plant empire strikes back: *Geo* 12:82-91.

This brief article, well written with excellent photos, covers various ways that plants combat animal predation or utilize animals to their purpose in unusual ways. Poisonous plant metabolites, orchid flowers that mimic insects and trigger plants are covered. In addition, there is some discussion

of CP, particularly in Australia. There are two full page photos each of *Drosera gigantea* and *Byblis gigantea* with prey and flowers. (DES)

Thum, M. The significance of opportunistic predators for the sympatric carnivorous plant species *Drosera intermedia* and *Drosera rotundifolia*. *Oecologia* (Berl) 81(3): 397-400. 1989.

Using fruit flies as prey, the author shows that bog-dwelling ants steal 3 times more prey from *D. rotundifolia* than *D. intermedia* in field studies. The advantage of plundering seems to be more important for the ants than the danger of being caught.

Thum, M. The significance of carnivory for fitness of *Drosera* in its natural habitat: the amount of captured prey and its effect on *Drosera intermedia* and *Drosera rotundifolia*. *Oecologia* (Berl) 81(3): 401-411. 1989.

In this two-year study, the author noted the benefits obtained from prey are partially transferred to the next year by the winter bud. *D. rotundifolia* grew better on hilly mounds while *D. intermedia* preferred lower positions and influenced its neighborhood situation by reproducing by seeds or axillary buds. *D. rotundifolia* was only observed reproducing by seeds. Both plant species have similar prey biomass per plant biomass despite their differences in plant shape, size and microhabitats.

Ueda, Kunihiko. Phytogeography of Tokai hilly land (Japan). *Acta Phytotaxon Geobot.* 40(5/6): 190-202, 1989.

The hill and terrace regions around Ise Bay have endemic, semi-endemic and relic taxa growing in small mires. CP that were found are *Utricularia minutissima*, *Drosera indica* and *Drosera spathulata* ssp. *tokaiensis*.

REMINDER

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